SEVENTH ANNUAL REPORT

OF THE

Quebec Society for the Protection of Plants from Insects and Fungous Diseases

1914-1915

SUPPLEMENT TO THE REPORT OF
THE DEPARTMENT OF AGRICULTURE

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1915

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Quebec Society for the Protection of Plants from Insects and Fungous Diseases

1914-1915.

To the Honourable J. E. Caron, M.P.P.,
Minister of Agriculture,
Quebec.

Sir:—

I have the honour to present herewith the Seventh Annual Report of the Quebec Society for the Protection of Plants from Insects and Fungous Diseases, containing proceedings of the winter meeting of the Society, which was held at Macdonald College, Ste. Anne de Bellevue, Que., on the 11th of March, 1915.

Included are the papers that were read, and the reports of the officers of the Society.

I have the honour to be,

Sir,

Your obedient servant,

J. M. SWAINE,
Secretary-Treasurer.

Ottawa,
1915.

QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS

OFFICERS FOR 1915-1916

President—Professor W. Lochhead, Macdonald College.

Vice-President—Mr. Auguste Dupuis, Director of Fruit Experiment Stations, Village des Aulnaies, P.Q.

Secretary-Treasurer—J. M. Swaine, Assistant Entomologist for Forest Insects, C.E.F., Ottawa.

Curator and Librarian—P. I. Bryce, Assistant in Biology, Macdonald College.

Directors—Rev. Dr. Thos. Fyles, Ottawa.
Rev. Father Leopold, La Trappe.
Rev. Brother Victorin, Longueuil.
A. F. Winn, Esq., Montreal.
Rev. Prof. Fontanel, St. Mary's College, Montreal.
Rev. Abbé Huard, Provincial Entomologist, Que.
G. Chagnon, Esq., Montreal.
Dr. Hamilton, Macdonald College.

Auditors—E. M. Duporte, Macdonald College.
Dr. Hamilton, Macdonald College.

Delegate to the Royal Society of Canada—Prof. Lochhead, Macdonald College.

Delegates to the Ontario Entomological Society—Mr. Chapais, St. Denis, Que.; Mr. Winn, Montreal; Father Leopold, La Trappe.

MEMBERS OF THE QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS.

Adams, Prof. John ..... Dept. of Agr., Ottawa
Blair, W. Saxby ..... Kentville, N. S.
Beaulieu, G ..... Dept. of Agr., Ottawa
Benjamin, Rev. Bro ..... La Trappe, Que.
Bois, Rev. Honorius ..... Ste. Anne de la Pocatière
Bouchard, Geo ..... Ste. Anne de la Pocatière
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Bunting, T. G ..... Macdonald College
Campbell, Rev. Dr. Robt ..... 68 St. Famille St., Montreal
Chagnon, G ..... M. L. H. & P. Co., Montreal
Chapais, J. C ..... St. Denis-en-bas, Que.
Chrystal, R. N ..... Dept. of Agr., Ottawa
Cloutier, H ..... La Trappe, Que.
Corcoran, Rev. Prof. ..... Loyola College, Montreal
Collingwood, G. F ..... Macdonald College
Cowan, P. R ..... Macdonald College
Cutler, G. H ..... Saskatoon, Sask.
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Dash, J. S ..... Dept. of Agric., Barbados, W. I.
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Drayton, F. L ..... C. E. F. Ottawa
Dreher, W. C ..... Dept. of Agr., Ottawa
Duporte, E. M ..... Macdonald College
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Fontanel, Rev. Prof ..... St. Mary's College, Montreal
Fraser, W. P ..... Macdonald College
Fyles, Rev. Dr. Thos. W ..... 368 Frank St., Ottawa

Gibson, Arthur ..... Dept. of Agr., Ottawa
Gooderham, C. B ..... Macdonald College
Gosselin, Alfred ..... Ste. Anne de la Pocatiere
Grignon, Dr. W. ..... Ste-Adèle, Que.
Gussow, H. T. ..... Dept. of Agr., Ottawa
Hall, Landon ..... Cowansville, Que.
Hamilton, Dr. D. W. ..... Macdonald College
Hammond, H. S. ..... Macdonald College
Harrison, Dr. F. C. ..... Macdonald College
Hewitt, Dr. C. G. ..... Ottawa
Honoré, Rev. Father ..... La Trappe, Que.
Huard, Rev. Abbé ..... Laval University, Que.
Husk, R. E. ..... Huntingdon, Que.
Hutchings, C. B ..... Macdonald College
Jack, Norman E. ..... Chateauguay Basin, Que.
Jenkins, M. H. ..... Ottawa, Ont.
Keating, Rev. Prof. ..... Loyola College, Montreal
Leopold, Rev. Father ..... La Trappe, Que.
Levasseur, Rev. Paul ..... Ste. Anne de la Pocatiere
Liguori, Rev. Brother ..... La Trappe, Que.
Lloyd, F. E. ..... McGill University, Montreal
Lochhead, W. ..... Macdonald College
MacClement, Dr. W. T. ..... Queen's University, Kingston, Ontario
McCormick, J. H. ..... Macdonald College
McLennan, A. H. ..... Macdonald College
McMahon, E. A ..... Macdonald College
McOuat, J. E. ..... Macdonald College
Moore, G. A. ..... Montreal
Nagant, H. ..... Quebec
Pacquet, Jos. ..... Ste. Anne de la Pocatiere
Piché, G. C. ..... Chief Forester, Quebec
Raymond, A. C. ..... La Trappe, Que.
Reid, Peter ..... Chateauguay Basin, Que.
Reid, B. T. ..... Woodstock, N.B.
Robinson, J. M. ..... Kentville, N.S.
Roy, H. B. ..... Macdonald College
Sadler, W. ..... Macdonald College
Savoie, Narcisse ..... Ste. Anne de la Pocatiere
Schafheitlin, A. O. ..... Macdonald College
Simard, J ..... Dept. Agr., Quebec, Que.
Sousie, Rev. Prof. ..... St. Mary's College, Montreal

Straight, E. M. ..... So. Portland, Me.
Strickland, E. H. ..... Entomological Branch, Ottawa
Summerby, R. ..... Macdonald College
Swaine, J. M. ..... Dept. of Agr., Ottawa
Tourchot, A. L. ..... St. Hyacinthe, Que.
Vanderleck, J. ..... Macdonald College
Victorin, Rev. Bro. ..... Longueuil, Que.
Winn, A. F. ..... 32 Springfield Ave., Westmount

HONORARY MEMBER:

James W. Robertson, Esq., LL.D., C.M.G.

FINANCIAL STATEMENT OF THE QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS FROM INSECTS AND FUNGOUS DISEASES, 1914

Receipts

Brought forward from last year	$306.01
Provincial Government Grant	250.00
Interest on Deposit to December 31st, 1914	5.60
	$561.61

Disbursements

Salary of Secretary-Treasurer	$ 50.00
Expenses, postage, stationery, express, etc	20.00
Cost of publishing French edition of the Fifth Report, La Tribune Sherbrooke	15.00
Cost of publishing English and French editions and separates of Sixth Report, Trades Publishing Co., Montreal	180.00
	$265.00
Balance Cash on hand, March 11th, 1915	$296.61
	$561.61

J. M. SWAINE, Secretary-Treasurer,
W. LOCHHEAD, President.

Auditors:—

E. M. DUPORTE,
D. W. HAMILTON.

SEVENTH ANNUAL REPORT OF THE QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS

Report of the Winter Meeting

The Seventh Annual Meeting of the Quebec Society for the Protection of Plants was held at Macdonald College on March 11th, 1915. The **opening business meeting** was called to order by the president, Professor Lochhead, at 2 p.m. There were present Professor Lochhead, Macdonald College; Father Leopold, La Trappe; J. C. Chapais, St. Denis-en-Bas, Que.; Professor W. P. Fraser, Macdonald College; P. I. Bryce, Macdonald College; E. M. DuPorte, Macdonald College; Revs. Fontanel and Sousie, St. Mary's College, Montreal; Revs. Keating and Corcoran, Loyola College, Montreal; Professor Adams, and Messrs. Strickland and Chrystal of Ottawa.

The minutes of the last meeting as published in the Sixth Annual Report were read and approved.

Letters of regret for inability to attend the meeting were read from J. M. Swaine, Secretary-Treasurer; Dr. C. G. Hewitt, Dr. Fyles, H. T. Gussow, Dr. R. Campbell; Rev. Abbé Huard, G. C. Piché,

In the absence of the Treasurer the President presented the financial statement for the year, which was accepted.

The President reported on the progress since the last meeting of the scheme for the publication of a new Flora of the Province of Quebec. He stated that Brother Victorin was prepared under certain conditions to undertake the systematic work in connection with it. The illness of Professor Lloyd will delay the section which he intended to undertake, but other members were prepared to undertake work in connection with the preparation of the new work. Mr. Chapais brought in a resolution, seconded by Father Leopold, that the Minister of Agriculture, Quebec, be asked to translate and publish the "Synopsis of Economic Entomology," prepared by the President, for use in the Normal Schools, Agricultural Schools and other Colleges in the Province.

The President also reported that a List of Diptera of the Province of Quebec would be ready for publication in the next report.

It was also resolved that the usual grant be made available from the Society's funds for expenses in connection with special investigations in insects and fungous diseases in this Province, and for any expenses in connection with the preparation of the list of insects.

The following officers were elected for the ensuing year:—

PRESIDENT—Professor Lochhead, Macdonald College.

VICE-PRESIDENT—M. Auguste Dupuis, Director of Fruit Experiment Station, Village des Aulnaies, Que.

SECRETARY-TREASURER—J. M. Swaine, Assistant Entomologist for Forest Insects, Ottawa.

CURATOR AND LIBRARIAN—P. I. Bryce, Assistant in Biology, Macdonald College.

DIRECTORS—Rev. Dr. Thos. Fyles, Ottawa.
Rev. Father Leopold, La Trappe.
Rev. Brother Victorin, Longueuil.
A. F. Winn, Esq., Montreal.
Prof. Fontanel, St. Mary's College, Montreal.
Rev. Abbé Huard, Provincial Entomologist, Quebec.
G. Chagnon, Esq., Montreal.
Dr. Hamilton, Macdonald College.

AUDITORS— E. M. DuPorte, Macdonald College.
Dr. Hamilton, Macdonald College.

DELEGATE TO THE ROYAL SOCIETY OF CANADA—Professor Lochhead, Macdonald College.

DELEGATES TO THE ONTARIO ENTOMOLOGICAL SOCIETY—Mr. Chapais, St. Denis-en-Bas, Que.
Rev. Father Leopold, La Trappe, Que.
A. F. Winn, Esq., Montreal.

The following Resolutions were passed after careful discussion:—

Resolution I.

WHEREAS the Woolly Aphis is an insect widely distributed through the Province of Quebec; WHEREAS the aforesaid insect is not considered a noxious pest by our fruit-growers and entomologists; AND WHEREAS in Ontario and many of the States nurseries are not inspected for Woolly Aphis:—

IT IS RECOMMENDED that the Provincial inspector do not strictly enforce the Noxious Pests Act with regard to the Woolly Aphis in nurseries, and that he furnish a certificate permitting the shipment of nursery stock free from Woolly Aphis even where a few trees are found infested in a nursery.

Resolution II.

The Society very respectfully recommends to the Honourable Minister of Agriculture that before drafting legislation relative to the prevention or control of insects or fungous diseases, the Provincial Entomologist give a hearing to a Committee named by this Society.

GENERAL SESSION

The General Session of the Seventh Annual Meeting of the Quebec Society for the Protection of Plants was the most successful in its history. The addresses given were full of interest, and contained much valuable information on the control of injurious insects, plant diseases and weeds. The following persons were present: J. C. Chapais, St. Denis-en-bas, Father Leopold, Bro. Benjamin and eight senior students of the Oka Agricultural Institute; Revs. Fontanel and Sousie of the Marie College; Revs. Keating and Corcoran of Loyla College, Montreal; Professor Crosby of Cornell University; Professor Adams, and Messrs. Strickland and Chrystal of Ottawa; A. F. Wynn and G. A. Moore of Montreal; Dr. Harrison, Professors Lochhead, Bunting, Murray and Fraser; Messrs. P. I. Bryce, A. C. Gorham, E. M. DuPorte, and many students of Macdonald College.

Letters of regret at inability to attend the meeting were received from Rev. Abbé Huard of Quebec, Dr. R. Campbell of Montreal, Dr. C. G. Hewitt, A. Gibson, J. M. Swaine, Rev. Dr. Fyles and H. T. Gussow of Ottawa, and G. C. Piché of Quebec.

Papers and Addresses.

Mr. J. C. Chapais read a report as delegate from the Society to the Annual Meeting of the Ontario Entomological Society in Toronto last November. He also read an interesting paper on *Aphrophora spumaria*, the common spittle insect which forms the common frothy spittle mass on grass in meadows, describing its life-history and habits.

Mr. DuPorte read an interesting paper prepared by Brother Victorin of Longueuil College on "Some Silent Invaders of our Fields," in which a warning was given regarding some weeds that were entering the Province, and were likely to become serious pests if timely action were not taken.

Mr. Strickland of the Entomological Branch, Ottawa, gave a valuable address with lantern slides on the Inspection and other work carried on by the Branch against the Brown-tail Moth in New Brunswick and Nova Scotia.

Father Leopold read a most interesting paper on the Woolly Aphis in the Province of Quebec in which he showed clearly that while this insect

was present in the Province, its work was not severe, and that a strict enforcement of the Noxious Pests Act was neither necessary nor in the best interests of the fruit-grower. In other provinces and States orchards and nurseries were not inspected for the Woolly Aphis. Professors Crosby of Cornell, and Lochhead and Bunting of Macdonald agreed with the views held by Father Leopold, and a resolution was passed by the Society asking the Minister of Agriculture to allow the shipment of nursery stock free from woolly aphis from nurseries where it is found that only a few trees are infested.

Mr. Chrystal of the Entomological Branch, Ottawa, gave an excellent address, illustrated with lantern views, on the Ravages of Insects in Stanley Park, Vancouver, with suggestions for their control.

Professor John Adams, Assistant Dominion Botanist, C.E.F. Ottawa, read an interesting paper on "The Medicinal Plants of Quebec" in which he gave a list of such plants and outlined proper methods of gathering and curing them. He showed that with proper attention a profitable industry might be established.

Professor Adams also read a paper prepared by Mr. H. T. Gussow, Dominion Botanist, on "Potato Diseases." A description of the chief diseases was given, with the best methods for their control.

In his presidential address Professor Lochhead discussed "The Web of Life" in which he tried to show that all Nature is full of inter-relations, forming a series of linkages so that one form is dependent upon others. Disturbances of any part of this web are likely to be followed by disturbances in other parts, Many examples were given of these inter-relations in Nature, and their economic importance to man.

Professor Crosby of Cornell University gave a most valuable illustrated address on "Some Successes and Failures in Controlling Insects." He confined his remarks mainly to his experimental spraying operations in 1913 and 1914 against Leaf-rollers, Codling Worms, and Red Bugs in the orchards of New York State. He showed the possibilities of the dust-spray in dealing with the first two insects. He thought the dust-spray would soon become a valuable auxiliary to the liquid spray in the control of orchard pests.

On account of lack of time a paper by Mr. DuPorte on "The Parasites of the Bud Moth," one by Mr. Bryce on "Immunity of Orchard Trees from Disease," one by Professor Fraser on "Cereal Rusts" and one by A. F. Winn on "Books about Butterflies" were read by title only. They will appear, however, in the forthcoming Annual Report of the Society.

PRESIDENT'S ADDRESS.

W. Lochhead, Macdonald College.

Gentlemen,—

Our Society, founded seven years ago for the express purpose of preventing the large losses incurred every year by our cultivated plants through attacks by insects and fungous diseases, has become, I believe, a permanent organization of the Province of Quebec, largely on account of the good work that has been done. It is essentially a provincial society, comprising both French and English speaking active members, and supported by a liberal grant from the provincial Department of Agriculture. While our actual membership is not as large as we would wish yet we are pleased to know that the accomplished work, represented by our Annual Reports of which six have already been published, has been appreciated by the officials of the Department and by others whose opinions we value. A recent number of "Science" contained a very flattering review of our Sixth Report, and congratulated the Society on the practical nature of the articles published.

Our good friend Mr. Chapais, whose presence, interest and opinions we highly appreciate, has been good enough to publish a valuable and timely article in both editions of the Journal of Agriculture commending the Society to the people of Quebec, and inviting all persons interested in the work of the Society to become members. I have already received several letters from teachers and professors expressing approval of the Society and a desire to become members. This is all very encouraging. Our Reports are bringing together in available form year by year a large amount of most valuable information for present and future workers in this Province. Our earnest desire is to help the agricultural interests of the Province, and in no better way can help be given than by the publication of facts and data regarding the distribution of plant pests, their range of activity, and the latest information as to their control. A series of Reports such as ours will, therefore, in my estimation be of great service in furthering the best interests of agriculture.

Patriotism and Production.

At this crisis of our Country's history when all eyes are focussed on the gigantic struggle taking place in Europe, where the nations engaged are straining every nerve to ensure victory, it is becoming more apparent

every day that the matter of food supplies will play a prominent part in bringing the war to an early close. The nations at war require food supplies, and will continue to require them for many years on account of the enormous number of agricultural labourers who have gone to the fighting zones. Canada can do a great service to the Empire by increasing both the areas devoted to the production of grain and the quantity of livestock. While the present campaign—Patriotism and Production—will no doubt result in stimulating farm production along every line there is a special need for a strong movement to protect the crops grown from insects and plant diseases. When it is realized that on an average one-tenth to one-fifth of our farm crops is lost every year by such agencies it is clear that if the farmers would put into practice the methods which Societies such as ours advocate, the net increase of crop yield would be millions of bushels. There is no more feasible method of increasing production than the prevention of losses. While, therefore, we give attention to increased acreage, we should not forget to use all the means in our power to keep the insects and fungous diseases in check.

Some Important Insecticides.

During the past season certain insect outbreaks of a threatening nature occurred in the Province. I refer to the Army-Worm which did considerable damage in Pontiac and Portneuf counties. Fortunately the outbreak was observed early, and preventive measures were taken. In connection with the control of this pest in Ontario it was found that where the poison bran-molasses bait was used, the addition of lemon juice increased its attractiveness for the army-worms, with corresponding greater mortality of the insects. As the poison bait is generally recognised as the best method of preventing attacks of cutworms in spring the addition of lemon juice is strongly advised.

Again, in the case of onion maggots the usual treatment has been directed against the egg and the maggot, but recent experiments carried out in Wisconsin reveal the fact that a poison bait spray is effective against the adult fly from the time it emerges until it lays its eggs, a period of 10 to 14 days. The poison bait spray used was composed of five grains of sodium arsenite dissolved in a gallon of boiling water with which is thoroughly mixed a pint of New Orleans molasses. This bait is applied as a coarse spray of large drops once a week in strips across the onion field throughout the summer.

Some Recent Publications.

The past year has been fruitful as to the number of important publications issued. First and foremost from our standpoint is the "Manual of Fruit Insects" prepared by Slingerland and Crosby and published by the Macmillan Company. This valuable work is a most comprehensive treatise on fruit insects, and makes available to students and the general reader the large number of observations and experiments carried on by many workers in recent years. Second, we welcome the "Handbook of Medical Entomology" prepared by Doctors Riley and Johanssen, also of Cornell, and published by the Comstock Publishing Company. The importance of insects as carriers of disease is becoming better recognized, and this recent publication places the latest information at the disposal of the public. The third publication is "Injurious Insects to the Household" by G. W. Herrick, published by the Macmillan Company. The fourth work is the "Manual of Weeds" by Miss Ada Georgia, published by the Macmillan Company. This book is a fairly complete treatise on weeds and furnishes much interesting and valuable information in a very readable form. The illustrations are excellent.

THE WEB OF LIFE.

Prof. W. Lochhead, Macdonald College.

Perhaps no idea is so full of practical importance to man as the one elaborated by Charles Darwin under the general name of Inter-relations in Nature. By a number of examples Darwin showed clearly that all Nature is a vast system of linkages, one part dependent upon another in an intricate web of life. His most familiar example is perhaps the relation between cats and clover, where clover depends upon bumble bees for the production of seed, and bees are destroyed by field mice and the mice are kept in check by cats. So the story runs: the more cats the fewer field mice, a larger number of bees, a larger crop of clover seed.

"Web of Life."

Again, Darwin's masterly work on Earthworms made clear that they are most important agents in maintaining the fertility of the soil and therefore the bread supply of the world. He showed that there often are 50,000 (and there may be 500,000) earthworms in an acre (England), that they often pass ten tons of soil per acre per annum through their bodies; and that they often cover the surface at the rate of three inches in fifteen years.

Since Darwin's time the number of examples of inter-relations has been greatly extended through the observations of thousands of investigators. In our boyhood days we were accustomed to rhyme the chain of events in the House that Jack Built, which ends with "This is the cat that killed the rat that ate the malt that lay in the house that Jack built." In Nature many such chains have been unravelled binding animal with animal and animals with plants and these again with the inorganic world. Man eats the fishes that eat crustacea that eat infusoria that eat bacteria that feed on decaying organic matter in some pond.

The metaphor "Web of Life" may be used in two ways. "On the one hand, Nature has a woven pattern which Science seeks to read, each science following the threads of a particular colour. There is a warp and a woof with interlinking and ramifying. We can never tell where a thread will lead to. If one be pulled out many are loosened.

The "Web of Life" suggests also the web of a spider, often an intricate system with part delicately bound to part so that the whole system is made

one. So in the substantial fabric of the world part is bound to part. In wind and weather, or in the business of our life, we are daily made aware of results whose first conditions are very remote; and chains of influence, not difficult to demonstrate, link man to beast and flower to insect. The more we know of our surroundings the more we realize that Nature is a vast system of linkages, that isolation is impossible."

The Balance of Nature.

Nature has evolved not as independent but often as closely dependent organisms. The well-being of one set is frequently related in many ways to other sets, and no creature can be said to live unto itself. Insects and plants, for example, have been for long ages mutually adapting themselves one to the other, the plant to the insect and the insect to the plant. We all know how birds keep down insects and many rodents; in fact, an approximate equilibrium has been established between them. Any disturbance or sudden reduction in the numbers of the birds of a region is sure to disturb the equilibrium or balance in the insect world and cause much loss to the crops upon which the insects feed.

Moreover, the number of carnivorous animals bears a definite proportion to the herbivorous animals upon which they feed, the herbivorous animals to the plants, the plants to insect visitors, etc., In this web of Nature we may note that the animals preyed upon are more prolific than the predaceous forms. "Small rodents tend to be much more prolific than carnivores. The primary reason for this is probably that less individuated types tend to be more prolific."—(Thomson).

Drs. Russell and Hutchison of the Rothamsted Station have shown that fertility of the soil depends upon the number of certain protozoa in the soil. These feed upon the bacteria which work up available plant food and if they are reduced in numbers the bacteria multiply and perform their their beneficent mission.

Sometimes man interferes with the balance of Nature and serious consequences follow. Rats became a great plague in Jamaica and to offset them the mongoose, a weasel-like animal, was introduced. The mongoose made short work of the rats, but it turned its attention to useful animals such as poultry, ground-birds and insect-eating lizards and snakes. As a result injurious insects and ticks have increased greatly, and both plants and animals have suffered much injury.

The English sparrow was introduced into America about 1860, and soon increased and spread rapidly. It is blamed not only for driving

away useful birds, but also for causing *blackhead* or coccidiosis disease of poultry. Coccidia are found in large numbers in the intestine of the sparrow, but do little harm. When transferred to poultry, however, they cause serious trouble.

Organic and Inorganic Nature.

It is a fundamental fact of life that animals are dependent mainly upon green plants for their food-supply. Green plants are the only organisms that can manufacture organic substances out of simple inorganic materials such as water, carbon dioxide and soil salts. Green plants are therefore, the makers of the world's food substances, and any factor that interferes with the growth of such plants decreases the amount of food available for the support of animals. An instructive example of this relationship is given by Dr. E. J. Allen in his interesting observations on the correlation between catches of mackerel and the amount of sunlight. "The more sunshine in May, the more mackerel at Billingsgate." He shows that the number of mackerel taken in May is related to the amount of copepod plankton upon which the mackerel feed. Again, the copepods feed largely upon minute vegetable organisms such as diatoms in the plankton, and these depend for their production to a large extent upon the amount of sunshine available. Here it may be said that all fish is diatom.

When animals and plants die or when animals eat plants minute but beneficent organisms tear the tissues apart and cause disintegration. The highly complex substances are resolved into simpler ones, and finally into water, carbonic acid and mineral salts. Thus is the available supply of food material of the world maintained; the soil would soon become depleted if the materials were kept long locked up in the bodies of dead animals and plants. The delicacy of the adjustment between the organic and the inorganic may be illustrated by the fern growing in a sealed bottle in the museum or store room of the Rothamsted Experiment Station at Harpenden, England. Visitors to that celebrated Agricultural Station will probably be shown a sealed gallon bottle in which a fern is growing on a sample of soil, collected and stored in 1874—forty years ago. A few years after the sample was stored a fern plant was observed growing on the soil. Although the bottle is doubly sealed the fern plant continues to grow slowly. No air can enter or leave the bottle which stands on a shelf in a room lighted from the roof, and the direct sunlight it receives lasts only for a few hours on summer days. Given moisture and humus in the stored soil, the changes constitute almost a balance—the oxygen needed for respiration being provided by the few hours of photosynthesis, and the carbon dioxide required

for photosynthesis being provided by respiration and the slow decay of the organic matter in the humus.

Insects and Plants.

We are all familiar with the enormous losses produced every year by the action of insects and fungous diseases on our cultivated crops. But we should not fail to look at the other side of the shield, and ascertain how many plants are dependent upon insects for their fertilisation and the production of seed. In previous reports I have discussed this aspect in the articles entitled "Adaptations between Plants and Insects (Third Report pp. 43-45) and "Bees as Friends of the Agriculturist" (Fourth Report, pp. 71-95) and to those articles I beg to refer you for further details. To Darwin again are we specially indebted for his valuable researches in cross-and self-fertilisation among plants. Let one example here suffice. He planted 14 seeds of cross-fertilised seeds of pansy and an equal number of self-fertilized seeds. He found the average height of the plants arising from the cross-fertilised seeds to be 5.58 inches, that from the self-fertilised seeds 2.37 inches. Next year the cross-fertilised plants produced 167 pods, the self-fertilised plants produced 17 pods. In the year following the area covered by the cross-fertilised plants was about nine times as large as that covered by the self-fertilised plants.

During the ensuing winter which was severe, all self-fertilised plants were killed while the cross-fertilised plants survived and grew vigorously. Again, seeds from cross-fertilised flowers or plants that came from self-fertilised flowers, and seeds from cross-fertilised flowers or plants that came from cross-fertilised flowers were planted. The average height of six plants from the first set was 10.31 inches, that from the second set 12.56 inches.

With regard to red clover Darwin wrote:—"I have also found that the visits of bees are necessary for the fertilisation of some kinds of clover——thus, 100 heads of red clover (Trifolium pratense) produced 27,000 seeds, but the same number of protected heads produced not a single seed."

Insects and Disease.

In my paper in last year's report on "Insects and Disease" reference was made to the important part played by insects in the spread of many diseases. The Anopheles mosquito carries malarial organisms, the Stegomyia mosquito carries the yellow-fever organism, the house-fly tuberculosis, typhoid fever and other ailments, the stable-fly infantile paralysis, tsetse flies the terrible

sleeping sickness of Central Africa, rat-fleas plague, lice typhus fever, etc., etc. There is no longer any doubt as to the inter-relationships that exist in this part of the web of life.

Again, fishes furnish another link in the chain connecting mosquitoes and malaria. As is well known certain fishes feed upon mosquito larvae, and in many districts are undoubtedly instrumental in regulating the amount of malaria. It is believed that the presence of the small fish called "Millions" in Barbados is the reason why that Island is so free from malaria.

Insects and Birds.

Facts which convince even the most sceptical are accumulating regarding the valuable rôle played by birds in the control of noxious insects. Studies of bird diets prove conclusively that the majority of our common birds feed mainly upon insects. Forbes of Illinois states after a careful study of the contents of the stomachs of birds that about **two-thirds** of the food of birds consists of insects. Well-informed writers tell us that without birds the earth would be uninhabitable after six years, and yet man in his ignorance is constantly destroying these valuable friends, simply because he finds that they levy an insignificant toll on his fruits and grains. It is possible that we would be better off if certain birds were greatly reduced in numbers, but of this we are not absolutely certain, for the web of life is most complex, and no person knows how far-reaching the results would be.

Aside from the fact that birds aid very materially in reducing the numbers of insects when they come as scourges, it is very important to remember that birds nip many incipient scourges in the bud. Their mobility and varied character and habits enable them to move rapidly from place to place and thus maintain the balance of nature which man is always tending to upset. Even in wild nature the balance is never quite complete; at best the equilibrium is unstable.

"It is very interesting that the two great classes of successful fliers should be, in the wide economics of Nature, fitted against one another, wings against wings, freeman against freeman, invertebrate against vertebrate, "little brain" against "big brain," "instinct" against "intelligence." **Practically** this is the most important conflict of classes that the world knows."—(Thomson).

Parasitic Insects.

The role of parasitic insects in the control of injurious forms is better understood today than ever before, but here again the web is very complex on account of the presence of secondary and tertiary forms. Man is beginning to utilise parasitic insects in controlling some of the serious pests (See my article on "Parasitic Insects" in the Fifth Report). It is probable, however, that man will never have full control of parasitic forms. Their influence will appear without any effort on his part. Army worm and tent caterpillar scourges come and go, but we are to a large extent ignorant of the real causes of their fluctuations. To what extent climatic conditions and parasites are responsible for the oscillations in their numbers we are not certain. We cannot yet predict the time of recurrence of army worm visitations. Possibly other and unknown factors are partly responsible for their appearance.. The time is still far distant when we will be able to suppress insect outbreaks by having on hand a supply of parasitic forms ready to be liberated at the proper time.

The Web of Life.

Only a few of the threads of the intricate web of life have been touched in this short discussion. Examples may be found everywhere about us in nature.

Sir Ray Lankester gives an illuminating classification of the economic relations between animals and man as follows:—

A. Those animals captured or slaughtered for food and other products.

B. Those bred or cultivated for food and other products.

C. Those promoting operations of civilised man, but not by being killed, captured or trained—scavengers, burying beetles, earthworms, pollinating insects.

D. Those causing bodily injury, death, disease, e.g., lions, wolves, snakes, stinging insects, germ-carriers, parasites, worms, etc.

E. Those injuring man's domestic animals, cultivated plants, or wild forms important to him—e.g., as in D, but also injurious insects, voles, etc.

F. Those injurious to man's worked-up products of art and industry, such as buildings, furniture, books, clothes, foods and stores.

G. Those beneficial in checking the increase of D,E,F., e.g., certain carnivorous and insectivorous birds, reptiles and amphibians; some parasitic and predaceous insects.

He who studies attentively any common plant or animal may form a conception, often an imperfect one, of the widely extending lines and cross lines of inter-relationships with other plants and animals. The work of science is to classify and describe these inter-relations, and in this line much progress has been made since Darwin's day. The economic entomologist and botanist, who are specially interested in the control of injurious insects and plants, must keep constantly in view this idea of relationships in Nature if they would deal successfully with the problems confronting them.

At the recent meeting of the American Association of Economic Entomologists at Philadelphia many prominent leaders emphasized the necessity for a more thorough biological study of all injurious forms. In other words, more attention should be given to oecologic or bionomic relations; that is, to the study of the Web of Life.

A knowledge of inter-relations, even in departments not usually considered in close alliance, is often essential in unravelling the intricate pattern of life's web.

"All fields are but perfectly fitted portions of a cosmic whole, and that, as the botanist and the astronomer in particular must come to know—

"Thou canst not stir a flower
Without troubling a star."

"Over a ploughed field in the summer morning we see the spider-webs in thousands, glistening with dew-drops, and this is an emblem of the intricacy of the threads in the web of life—to be seen more and more as our eyes grow clear. Or, is not the face of Nature like the surface of a gentle stream, where hundreds of dimpling circles touch and influence one another in an intricate complexity of action and reaction beyond the ken of the wisest?"—(Thomson).

To Prof. J. Arthur Thomson of Aberdeen I am much indebted for many fine illustrations of the Web of Life. "The Study of Animal Life," "Darwinism and Human Life," and "The Wonder of Life" are books which will hold the interest of every student of Nature. No clearer exposition of those phases of life which fall under the general titles of **Struggle for Existence** and the Web of Life can be found anywhere else in the English language.

SOME SUCCESSES AND FAILURES IN CONTROLLING INSECTS IN 1914

By C. R. Crosby, Cornell University

(Abstract)

The season of 1914 was an interesting one for the Entomologists of New York. Severe outbreaks of army worms and grass-hoppers occurred in many parts of the State. The fruit-tree leaf-roller, the green fruit-worms, the green and rosy aphis and apple red bugs have been very abundant in the orchards of the State and in many places have caused severe injury.

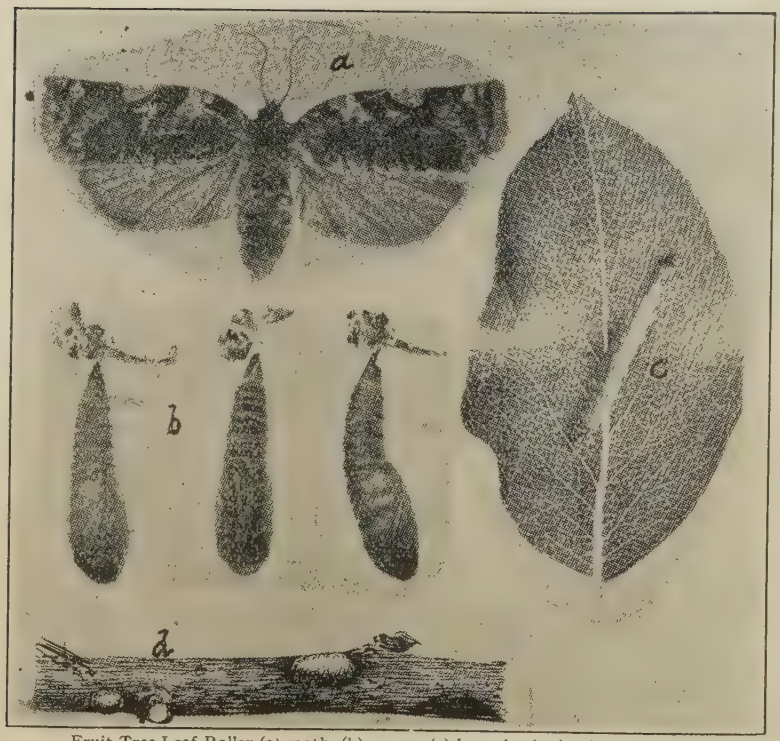
In this paper I shall discuss only two of these pests, the fruit-tree leaf-roller and the apple red bugs. In addition, I shall attempt to give an account of a series of experiments conducted to determine the effectiveness, cost, and general practicability of the dusting method of applying insecticides and fungicides to apple trees.

The Fruit-Tree Leaf-Roller.

Archips argyrospila Walker.

The fruit-tree leaf-roller has been a serious enemy of the apple for some years in the orchards of Colorado and Missouri. The insect has been found in New York State since 1874 but it was not until 1911 that it became a serious pest. During the spring of that year, the insects appeared in large numbers in the orchards of Genesee County and caused great loss to the crop. Since that time it has been gradually increasing in importance until during the past year it caused more or less injury in most orchards throughout the apple growing sections and was very injurious in a few widely separated localities.

The insect hibernates in the egg stage. The eggs are attached to the twigs and smaller branches in small, oval, flat greyish patches about one-quarter of an inch in diameter. The number of eggs in each mass varies considerably but the average is about 105. Each mass is covered with a smooth varnish-like substance impervious to the lime-sulfur solution. The eggs hatch just as the buds are opening and the small black-headed green caterpillars burrow into the bursting buds and later feed on the opening leaves and blossoms. The caterpillars tie together the young leaves and blossoms with a silken web often curling or rolling the leaves in which they rest. As soon as the blossoms fall the partly grown caterpillars begin feeding on the young fruits in which they eat out large irregular cavities. The fruits most severely injured soon fall but those less badly eaten may mature, but are knotty and unmarketable. The wound made by the caterpillars heals over, leaving a brownish corky scar. In some orchards, where the in-



Fruit-Tree Leaf-Roller (a) moth, (b) pupae, (c) larva beginning its nest on an apple leaf, (d) egg patches (after Herrick).

festation was most severe the trees were completely defoliated and the caterpillars not having enough food to complete their growth were forced to descend to the ground and feed on the clover cover-crop growing in the orchard. In New York the caterpillars became full grown in three weeks. They are then about one inch in length, light green in color with the head, legs and thoracic shield varying from brown to black. When full-grown they transform within a rolled leaf into brownish pupae and in about ten days, or early in June, the moths emerge. The front wings are mottled with various shades of brown and yellowish white, and there is considerable variation in the distinctness of the markings in different individuals. The female moth deposits her eggs soon after emergence. In New York most of the eggs are laid before the first of July but they do not hatch until the following spring. There is only one brood annually, about ten months of the year being spent in the egg stage.

Means of Control.—The fruit-tree leaf-roller has been found a most difficult insect to control. The young caterpillars burrow into the buds

before feeding to any great extent on the exposed surfaces. Later they feed under the protection of the webbed leaves and blossoms where it is very difficult to reach them with the poison spray. By the time the fruit is attacked the caterpillars are nearly half grown and very resistent to arsenical poisons. Attempts to destroy them by the use of arsenate of lead at this time have been generally unsuccessful. Fortunately very effective work can be done against the eggs. While the varnish-like covering of the egg masses is impervious to the lime-sulfur solution it is readily permeated by the miscible oils. Experiments conducted in Colorado and more recently in New York have shown that more than 75 per cent of the eggs can be killed by spraying with a miscible oil, one part in fifteen parts of water, making the application just before the buds open and therefore just before hatching would take place. This is also the safest time of the year to use miscible oils, there being less danger of injury to the trees in the spring when the sap is moving than in the fall or winter when the activity of the tree is dormant. One cannot expect to entirely prevent injury by leaf-rollers by spraying to destroy the eggs. There will always be some eggs that are not hit by the spray and from these caterpillars will develop. The oil treatment should always be supplemented by careful and thorough spraying with arsenate of lead, 5 to 6 pounds in 100 gallons of water, making one or two applications just after the buds open and before the caterpillars have been able to find protection under their webs. The system of spraying adopted in any particular orchard will depend on the severity of the infestation. Where only a few scattering egg-masses are present it would not pay to use the miscible oils and reliance should be placed on thorough work with arsenate of lead. In case of severe infestation it is necessary to use the miscible oils supplemented by thorough spraying with arsenicals.

Dusting Experiments on Apple.

The protection of our fruit trees from their numerous insect and fungous enemies by means of spraying with liquid substances has been in vogue for more than forty years and has reached a refinement of detail that would seem to leave little to be desired. The manufacturers of spray machinery are continually devising new and better types of nozzles, pumps, and engines. Manufacturers of chemicals are ever finding new spray materials or discovering new combinations of those already on the market. It has been the same with our official entomologists and plant pathologists. The main trend of their thought and endeavour has been along the line of liquid spraying. Under these circumstances it is no wonder that the possibilities of the dry or dust method of applying insecticides and fungicides has been neglected. Nor is it any wonder that when we begin to talk seriously of dusting as a

substitute for spraying the manufacturers of pumps and spray materials soon begin to show their opposition to the idea.

Leaving out of consideration the early practice of dusting trees with soot, ashes, lime, or road dust, the first scientific experiments in the use of dusting were conducted in the years 1904 to 1908 in the experiment stations of Illinois, Washington, Missouri and Delaware. In all these experiments the material used was dry Bordeaux and Paris green, or in one or two cases arsenate of lead. In other words the fungicidal agent was copper and the insecticide was Paris green. The results of these experiments prove conclusively that, except in cheapness, the dust method did not give so good results as can be obtained by ordinary spraying methods. In the few cases where arsenate of lead was used in these experiments the codling moth control was fairly good.

The revival of interest in the use of dust came as a result of the almost universal change from Bordeaux mixture to lime-sulfur as a fungicide for the control of apple scab, or a change from copper to sulfur as the fungicidal agent. With this change the use of Paris green was almost entirely abandoned since it could not be combined with lime sulfur solution without injury to the foliage.

When the lime sulfur solution is sprayed on a surface it soon disintegrates and sets free pure sulfur in a very finely divided state. It has been shown that it is this free sulfur that acts as a fungicide and prevents scab infection. Two facts lead to this conclusion as to the value of pure sulfur as a fungicide when present in a finely divided state; first, the success of Scott's so called self-boiled lime-sulfur for preventing brown rot of peach, and second, Wallace's results in using lime-sulfur in a carbonic-acid gas sprayer. In the latter case the sulfur is precipitated by the carbonic-acid and goes on the tree as finely divided pure sulfur. In Scott's self-boiled lime-sulfur, the sulfur is in a finely divided state caused by the slacking of the lime. From this it was only a step to the use of a finely ground sulfur applied as a dust.

The first dusting experiments with finely ground sulfur and powdered arsenate of lead at the Cornell University Experiment Station were made in 1911, but owing to the almost total lack of both scab and codling moth in the orchard used the results were practically worthless. The experiments were repeated in 1912 on a small scale but with encouraging results, as may be seen from the following table:—

Treatment	Scab	Codling Moth	Curculio
	%	%	%
Untreated	9.0	37.0	73.0
Lime-sulfur solution	0.7	5.7	5.2
Dust mixture	0.5	1.3	6.0

In 1913 the experiments were conducted on a larger scale but owing to illness the speaker's connection with the work was very slight after the general plan had been worked out. The results of the experiments in 1913 are shown in the following table:

Treatment	Scab	Codling Moth	Curculio
	%	%	%
Untreated	80	12.0	39
Lime-sulfur solution	21	1.4	23
Dust mixture	33	0.4	4

In 1914 we felt justified in enlarging the scope of the experiments. Three orchards were used located in different parts of the State: at Holley in the western part, at North Rose farther east but still in the Lake Ontario plain, and at Owego in the hill country near the southern border of the State. At Holley the variety was Baldwin; at North Rose, and Owego, Ben Davis. The value of the experiments at the last two places was destroyed because we were unable to make the applications at exactly the proper time. At Holley, however, the proper applications were made and satisfactory results obtained. This orchard consisted of very large Baldwin trees about fifty years of age. The orchard was divided into five plats each containing from thirty-eight to forty-three trees. One plat was left untreated as a check, the other four plats were treated with different materials as follows:—

1. Sulfur 80%, arsenate of lead 20%.
2. Sulfur 40%, arsenate of lead 10%, finely ground gypsum 50%.
3. Sulfur 40%, arsenate of lead 10%, hydrated lime 50%.
4. Lime-sulfur solution (30° Baumé) 2½ gallons, arsenate of lead 3 pounds, water to make 100 gallons.

The last plat was sprayed by the owner of the orchard according to his usual methods. The work was done with thoroughness and care and the applications were made on the same day as the dust applications. The dust was applied with an "Ideal" power dusting outfit operated by a 2½ h.p. horizontal gas engine, previous experiments having shown that the less powerful engine would not do satisfactory work.

The sulfur used in all the dust mixtures was flour sulfur very finely ground, so that 95% will pass through a screen having 200 meshes to the inch. On one plat it was used with arsenate of lead without dilution; on the other two plats the mixture was diluted by adding 50% of finely ground gypsum and hydrated lime, respectively. These diluents were added for the purpose of reducing the cost of the material and in order to make it possible to apply a smaller amount of the sulfur and arsenate of lead without missing parts of the trees.

The first application was made just as the blossoms were separating in the cluster on May 13th; the second, on June 1st, when the petals had all fallen from the trees, and the third application was made on June 18th. A fourth should have been made the last of July for the control of late scab but was omitted because the weather at that time was dry and there was no indication that the scab would become serious. This was an unfortunate decision because the very wet weather which followed in August gave a very serious infection of late scab.

Rains on May 11th, 12th and 13th, gave an infection of scab on the leaves around the cluster of blossoms but as the blossoms had not separated at that time no infection was present on the fruit stems. Infections occurred during rain periods on June 3rd, 4th and again on the 7th. There were rains on June 19th and 20th but fortunately the applications had been made the day previous.

Bud-moth and cigar-case bearers were fairly abundant early in the season. Leaf-roller was present and on June 1st the caterpillars had begun to eat the stamens and calyx lobes of the newly set apples. They were aided considerably in this work by the green fruit-worms. Codling moth was unusually scarce in this orchard as is shown by the count of the apples from the untreated plat, only about one per cent being infested.

In determining the degree of control, all the apples on three trees chosen from near the center of each block were examined and the injuries recorded on counting machines. The results are indicated in the following table:—

Treatment	Apple Scab Early %	Apple Scab Late %	Leaf-roller and green fruitworm %	Codling Moth %
Untreated	36.4	86.0	23.0	1.0
Lime-sulfur solution	7.0	15.0	13.0	.2
Sulfur 80%, Arsenate of lead 20%	3.8	14.0	8.5	.3
Sulfur 40%, Arsenate of lead 10%, Gypsum 50%	4.1	15.4	8.0	.01
Sulfur 40%, Arsenate of lead 10%, Hydrated Lime 50%	9.0	37.1	11.3	.17

From this table it will be seen that all the dust mixtures, except where lime was used as a diluent, gave better protection for the control of early infections of apple scab, than did the lime-sulfur solution. As previously stated, no application was made the last of July for the prevention of late scab and the data in regard to its prevalence are of interest only as showing

that the amount of late scab is directly proportionate to the amount of early infection.

In considering the control of leaf-roller and green fruit-worm, as indicated by the injured fruit, it should be remembered that the first applications were made several days too late for the most effective results. In regard to the codling moth, the infestation was too slight in this orchard,

Dust spraying in a New York Apple Orchard—Covering the inner foliage (Original).

as shown by the number of infested apples in the untreated plot, to make the figures of much value. The table shows however that in the control of the principal chewing insects, the dust mixtures, with the exception of the one containing lime, gave as good or better protection than did the lime-sulfur solution. The reason for the failure of the lime mixture is a question that can be settled only by repeating the experiment another year.

In all these experiments very careful records were made of the cost of the various materials and of applying them. The details of this record are given in the following table:—

Date of application	Plat	No. of trees	Material used, and strength	Quantity used	Time required						Cost			Cost per tree
					Horse		Man		Machine					
					Hrs.	Min.	Hrs.	Min.	Hrs.	Min.	Labor	Material	Total cost	
				(Lbs.)										
May 13	2	38	Sulfur 40%, lead arsenate 10%, hydrated lime 50%	60	1	12	1	12	0	36	$ .36	$ 1.70	$ 2.06	$.054
June 1	2	38		140	1	20	1	20	0	40	.40	3.98	4.38	.115
June 18	2	38		160	1	32	1	32	0	46	.46	4.54	5.00	.131
Totals..	.....	.....	.....	360	4	04	4	04	2	02	$1.22	$10.22	$11.44	.300
May 13	3	43	Sulfur 80%, lead arsenate 20%.....	100	0	40	0	40	0	20	$ .20	$ 5.28	$ 5.48	$.127
June 1	3	43		160	1	18	1	18	0	39	.39	8.45	8.84	.205
June 18	3	43		195	1	28	1	28	0	44	.44	10.30	10.74	.250
Totals..	.....	.....	.....	455	3	26	3	26	1	43	$1.03	$24.03	$25.06	$.582
May 13	5	41	Sulfur 40%, lead arsenate 10%, gypsum 50%....	80	0	42	..	42	0	21	$ .21	$ 2.27	$ 2.48	$.060
June 1	5	41		170	1	24	1	24	0	42	.42	4.83	5.25	.128
June 18	5	41		160	1	18	1	18	0	39	.39	4.54	4.93	.120
Totals..	.....	.....	.....	410	3	24	3	24	1	42	$1.02	$11.64	$12.66	$.308
				(Gals.)										
May 14	4	43	Lime-sulfur solution(32°) 2.5 gallons, lead arsen-	375	6	00	6	00	3	00	$1.80	$3.83	$5.63	$.131
June 1	4	43	ate 3 pounds, water to make 100 gallons.	375	6	00	6	00	3	00	1.80	3.83	5.63	.131
June 18-19	4	43		350	6	00	6	00	3	00	1.80	3.57	5.37	.124
Totals..	.....	.....	.....	1,100	18	00	18	00	9	00	$5.40	$11.23	$16.63	$.386

From the data given in this table it will be seen that the materials for dusting are more expensive than those for spraying but that the cost of application is greater for the spray than for the dust. In determining the cost of application, only the actual time of operation was counted, no account being taken of the time necessary to fill the sprayer tank or consumed in driving to and from the orchard with each load of spray material. If this

Dust spraying—covering the outer foliage (Original)

item had been added the difference in labor cost of the two methods would have been greater since enough of the dusting material can be carried on the wagon for a half day's work. The table also shows that in this orchard of very large old trees, the dusting was done five times as quickly as the spraying. On smaller trees this difference is not so great.

It is not probable that the dusting method of applying insecticides and fungicides will replace spraying but it has some advantages which render it

of great value under certain circumstances. As yet we have no way of controlling scale insects, aphis and red bugs by dusting. The commercial apple-grower will have to spray for these troubles as in the past. The dust method will be of most value to the man having a large orchard of big trees. It is a difficult task to complete the spraying of such orchards within the short periods which the rapid development of the blossoms leaves for the work. It often happens in Western New York that the time for effective spraying is confined to four days and one of these days occasionally falls on Sunday —a period much too short in which to spray fifty acres of large Baldwin or Greening trees. Of course the work could be done by employing a large force of men and teams and making use of several spray rigs, but with the press of other work at that season of the year, such a course is impracticable. The dust can be applied so much more rapidly—in about one-fifth of the time in such orchards—that its use will serve to help solve the problem. Furthermore, it often happens that the ground is so wet and soft as the time when the application should be made that it is impossible to use a heavy spraying rig. A dusting outfit is so light that it can be used at almost any time regardless of the condition of the ground.

At present the dusting method of applying insecticides and fungicides is to be advised only as supplementary to the usual spraying practices under certain conditions. It will also prove of value in the small home orchard; here the material can be applied with a small hand duster. A full account of these experiments will be found in bulletins 340 and 354 of the Cornell University Agricultural Experiment Station.

Apple Red Bugs.

The apple red bugs are native American insects that have only recently attracted attention by their attacks on apples. They were first observed by the late Professor M. V. Slingerland in 1894 but at that time seemed to be of little importance. In 1908 there occurred a serious outbreak in several New York orchards. Since that time they have been gradually becoming more numerous and destructive. There are two species of red bugs concerned in producing this injury to apples, one known as the true red bug and the other as the false. Both species pass the winter as eggs in the smaller apple twigs. The egg is inserted its full length into the bark and the cap at the truncate anterior end lies flush with the surface. The eggs of the true red bug are usually inserted at the base of the the fruit spurs or around the buds; those of the false red bug are usually inserted in the lenticels of the two-year-old wood. The eggs of the true red bug hatch just as the leaves around the

blossom cluster are unfolding; those of the false red bug hatch while the trees are in blossom. The young, brilliant red nymphs at first feed on the leaves which they puncture, causing reddish dots. They then attack the young apples as soon as they are formed. In feeding, the nymph inserts the bristles of its beak quite to the center of the young fruit. The tissue around the puncture hardens and turns black. Some of the punctured apples soon fall to the ground, a few of them dry up and remain on the trees until the following spring while others mature but are knotty and unmarketable. The nymphs pass through five immature stages and acquire wings at the last molt. The nymphs of the false red bug are of brighter color than those of the true red bug and are clothed with short black hairs and do not have the dusky markings on the thorax. Soon after becoming mature the females begin egg-laying. This operation has been observed by Mr. H. H. Knight who has published a very interesting account of the operation in the "Journal of Economic Entomology." The female first bores a hole through the bark with her beak and then enlarges it with the ovipositor. In this cavity, the eggs are deposited.

Control.—The young bugs can be killed by thorough spraying with "Black-leaf-40" tobacco extract, 1 pint in 100 gallons of water with 5 pounds of soap added to make the liquid stick and spread better. The tobacco extract can be combined with the dilute lime-sulphur solution as used for a summer spray. In case, however, the insects are extremely abundant it is necessary to use such large quantities of the liquid that the lime-sulphur may injure the foliage; in such cases a separate application should be made for the red bugs, using the tobacco extract with water and soap. The applications should be made first, as the blossoms begin to show pink, and second, as the last of the petals are falling. These applications coincide with those for the first scab spray and for the codling moth respectively.

APHROPHORA SPUMARIA—CUCKOO SPIT.

J. C. Chapais, St. Denis-en-bas, P.Q.

Very often, by the end of June, if you feel anxious to see how your hay is growing in your meadows and take a walk through them, you will find on your return that you have collected on your trousers some matter having very much the appearance of froth; and perhaps you will also have noticed some of this froth on a few of the hay plants, specially on timothy, in the meadow. The froth indicates simply the presence of an insect known under the scientific name of *Aphrophora spumaria*. As that insect sometimes causes some damage to certain plants, I purpose writing a short notice about it with the object of familiarizing the farmers with it and its habits.

I shall first give the scientific description together with the common appellations of the insect: **Class,** Insecta; **Order,** Hemiptera; **Sub-order** Homoptera; **Family,** Cicadellidae; **Genus,** Aphrophora; **Species,** Aphrophora spumaria. (From the Greek *Aphrophoros*—Foam-bearing.) This insect is also known under the common appellations of *cuckoo spit*, *frog spit*, and it is further called a cicadella, a name which is derived from that of the insect's family.

If you pull up a plant bearing one of those froth masses and blow lightly on it to lay bare the stem, you will find an insect of a greenish colour motionless under the foam which covered it, and this is the larva of the Aphrophora. It measures 0.19 to 0.51 of an inch in length; its general aspect gives it the appearance of a small cicada, hence the name of cicadella given to the family to which it belongs. It differs from the adult insect only by the absence of wings and of the genital organs. The head, the thorax and the legs are black. The abdomen, greenish and soft, has its last segment black. This larva is firmly fixed on the stem of the plant. Its little rostrum or beak, sunk in the soft tissues, sucks up the sap which constitutes its food; it throws out as excrement a semi-fluid matter into which it injects simultaneously gaseous bubbles. This frothy substance accumulates around the small larva and finally covers and hides it completely.

In that queer little den, the larva grows, and moults many times; the larval skins may be seen mixed with the froth. At the end of its development wing rudiments appear, and it is then a nymph. The froth emission stops at that time, and dries inside, a thin pellicle only being left.

The wings grow only after the last moulting; henceforward, it is a perfect insect, a cicadella. Its length is from 0.35 to 0.39 of an inch. It is of an ash-grey colour, with some lighter parts, looking like slanting streaks on the fore wings of the male. Like most of its congeners, it jumps nimbly.

The female lays its eggs in the fall of the year. They remain dormant during the winter and hatch in the following spring. Below Quebec, they hatch by the end of June.

By their punctures the larvae weaken the plants on which they live, turning the young shoots yellow. The damage is rarely considerable, the insects never showing in large numbers.

The larvae are easily destroyed. One may crush them between thumb and finger, or collect and burn them. A good way is to sprinkle the froth with powdered quick lime.

This insect is further known under the name of *Cercopis spumaria, Cercope écumeuse, cigale écumeuse.* As just mentioned above, it causes little damage, though it is found on a great variety of plants. It is seen sometimes in large quantities on young willow branches, to such a degree that under those trees the froth falls like drippings, commonly named "Willow tears." It causes sometimes much damage when it introduces itself in the frames and sometimes in the green-houses used for the forcing of roses, carnations, and strawberries.

REPORT OF THE DELEGATES TO THE ANNUAL CONVENTION OF THE ONTARIO ENTOMOLOGICAL SOCIETY.

J. C. Chapais, St. Denis-en-bas, P.Q.

During last November (1914), Reverend Father Leopold, O.C.R. and the writer had the pleasure of attending, as delegates of the Quebec Society for the Protection of Plants, the annual convention of the Ontario Entomological Society, held in Toronto, on the 5th and 6th of November.

The programme of the convention led us to believe it would offer much of interest to those who were to attend it, and we were not disappointed.

In the first place the reports of some of the directors of the Society on the injuries caused by various insects in the districts of the Province of Ontario which they represented were of the greatest interest, as well as the short biographical notice and bibliographical review of the life and works of J. H. Fabre, a renowned French contemporary naturalist, written and read in a very attractive way by Professor Lochhead of Macdonald College, President of the Quebec Society for the Protection of Plants.

The opening address of the President, Dr. C. Gordon Hewitt, was such as to awake the inquisitiveness of the members of the convention, even if only by its title: "History of Applied Entomology in the Dominion of Canada." This address was brimful of quite interesting information for all Canadian entomologists. The evening lecture was given by Professor J. H. Comstock, of Cornell University, on "The Habits of Spiders." A large audience was delighted with the most interesting lecture and the large number of beautiful lantern views. Then followed an essay on: "The Cherry-flies," by Professor Caesar of Guelph, Ont.; an excellent paper, as much interesting from the entomological viewpoint, as attractive through the original style of the writer, entitled "Mountains and Hills," by Reverend Dr. Fyles, of Ottawa; an essay of a quite special usefulness on the insect enemies of forest and ornamental trees, by Mr. J. M. Swaine, of Ottawa; and many other papers on the programme made of that meeting one of the best conventions attended by the hearers.

For us, the most interesting papers presented before the convention were two essays absolutely up to date on "The Army-Worm (*Leucania unipunctata, La Légionnaire*)" one by Mr. A. Gibson, of Ottawa, the other by Mr. A. W. Baker, of Guelph. These essays gave complete accounts of the Army-Worm caterpillars which have caused so much

damage in the Province of Ontario and in a few counties of the Province of Quebec, last summer. The damage caused to agriculture by these army-worms in the Dominion of Canada, last year, has been estimated at $300,000.

On the evening of the first day of the convention, after the regular meeting, the members of the Society and the delegates were entertained in the fourth year laboratory. Refreshments were served by the ladies of the Society.

We brought from that convention not only much valuable information that we gathered while attending it, but, besides, a pleasant recollection of the friendly connections entered into with the distinguished members of the Entomological Society of Ontario.

NURSERY INSPECTION IN THE PROVINCE OF QUEBEC.

Rev. Father Leopold, Oka Agricultural Institute, La Trappe, Que.

Though it is my intention to speak about the Woolly Aphis, I shall do so with one object in view: that is, its relation to inspection in the nursery row. This is the reason I am giving to my paper the title: "Nursey Inspection in the Province of Quebec."

This is now the second year only that nurseries have been inspected by a Provincial officer; the first year, in view of the fact that if one wished to import nursery stock of any description into the Province of Nova Scotia, he must have a certificate testifying especially that his trees were free from the San José scale. Last season, after a law had been passed at Quebec, the nurseries of the whole Province became subject to inspection.

The new act adopted last session enacts in substance as follows: "It is forbidden to sell in the Province, any nursery product grown in the Province if the proprietor has not received from the Provincial Entomologist or his representative a certificate of inspection mentioned in article 2041m." Now in this article the law enacts that the certificate is to be given only if the inspector does not notice the presence of any of the following insects or diseases:

1.	The San José Scale,	Aspidiotus perniciosus, Comst.
2.	The Brown Tail Moth,	Euproctis chrysorrhoea L.
3.	The Gypsy Moth,	Porthetria dispar L.
4.	The Woolly Aphis,	Schizoneura lanigera Hausm.
5.	The Black Knot,	Plowrightia morbosa. Sacc.
6.	Apple Canker,	Nectria ditissima Tul.
7.	Potato Canker,	Chrysophlyctis endobiotica Sch.

Now let me first say that in this law I am taking exception to the inclusion of the Woolly Aphis among the insects in the preceding list. I find that even if it were necessary to include the Woolly Aphis in the list, there ought not to be such a severe law such as the preceding one, prohibiting the sale of any tree if only a few trees are found infested.

The reason why I think that the Woolly Aphis should not be included among pests prohibited in our province is that in Quebec Province the Woolly Aphis is not an important pest, although it is very generally distributed. Professor Caesar, who is the Provincial Entomologist in Ontario,

writing to me on this subject, says: "We do not inspect any nursery in Ontario for Woolly Aphis": and the reason that Professor Caesar gives is the very one I have just mentioned: "in Ontario the Woolly Aphis is not a very important pest, although it is found all over the Province. I have never seen a tree that you would call very badly injured by this insect."

Woolly Aphis—(a) deformities on roots, (b) colonies on roots, (c) woolly aphis.

The really dangerous form of this insect scarcely occurs at all in Ontario, and I may say never occurs in the Province of Quecbec. I mean the root form which is so destructive in parts of the United States. The aerial form, which is our only common one, frequently causes little galls to form on new shoots and it also sometimes, on a badly infested shoot, will cause small cankered areas around a wound where it has fed; but it is only abundant in certain years, disappearing in the next or soon after.

The Woolly Aphis winters on the elm tree in the egg stage, and in the spring causes the peculiar curling of the elm leaves which we notice so often. Of course, a few may winter in the immature stage on young apple trees, near the base of the tree or under shelter on the bark; but these are very rare and I do not remember having seen any personally in this Province.

Personally, I am of the opinion, therefore, that the Woolly Aphis is not so serious a proposition in Canada, I am sure in our Province, at least, as it was thought a few years ago. We obtained much of our information regarding this pest from the South, in the States or in Europe, where the Woolly Aphis is undoubtedly a serious pest and does great damage, especially in the root form. There the winters are much milder, and the forms might live throughout the entire year either on the roots or on the stems. In Canada, however, it is different; the winters are cold, very cold in our Province, at least, and too cold for any stem-inhabiting forms to live through.

Now is the question of destruction of the Woolly Aphis an easy matter? Not at all. One may visit the nursery rows even once a week, and still find, some morning, that a colony of winged females have alighted from some elm. For, as already stated, the Woolly Aphis, after having passed the egg-condition and the two first Spring generations on the Elm, develops in the third generation the winged forms, which fly back to the apple and establish colonies there. You will see, therefore, that the whole question of prevention of the distribution of the Woolly Aphis is a most difficult one to cope with. So much so that the State Entomologist of Colorado, Mr. C. P. Gillette, after inspecting one year 36 nurseries, says that he did not find one single nursery exempt from the Woolly Aphis.

I have had some experience in nursery work for twelve years and I may say that I never have had to spray or bother about the Woolly Aphis in our nursery; so I am right, I believe, in my stand that in our Province the Woolly Aphis is not an important pest, and it is useless to quarantine a nursery on its sole account.

Of course I am not maintaining the same stand in regard to any of the other pests on the list referred to in the beginning of this paper. It is especially necessary to have the most stringent rules enacted to keep our Province absolutely free from any form of invasion of the San José scale, the Brown Tail Moth and the Gypsy Moth. Nurserymen and orchardists are as a whole very much interested, and I may say among those most interested in keeping our Province freed from such pests. And we only have to thank either the Federal or Provincial authorities for the inspection rules they have enforced in recent years.

But again, I do not place the Woolly Aphis in this class of pests, for the very reason that it is found everywhere already in the Province and it is not a very important pest; and that if importance is considered, the provincial authorities should begin by taking steps to prevent or control

the spread of such important pests as the Green Aphis and the Rosy Aphis, *Aphis mali* and *Aphis sorbi.*

My next stand is the following one: If the Provincial Government, for any reason, still retains this insect on its list of noxious insects in the Province of Quebec, on the same footing as the Brown Tail Moth, the Gypsy Moth and the San José Scale, then a certificate should be given to the nurseryman who destroys any noxious insect found upon a few trees in the nursery row. I can justify this stand by quoting you the following personal opinion of one who is in a position to speak to us officially as the Dominion Entomologist of Canada: "I may say that if as a result of the inspection of a nursery I only found a few trees infected with any insect scheduled as noxious I should be willing to furnish a certificate of nursery inspection, after all the trees which had been found infested had been destroyed in my presence; for I could then certify that the nursery was to my belief free from the insect pests in question."

Besides, this stand is in accordance with the universal practice of all nursery inspection; and just to give you an example, I may state that in the year 1911, out of a total of 864,946 apple trees inspected in Colorado, there were only 210 condemned for Aphids; and that out of a total for fruit trees of 1,286,509 that is, apple, pear, cherry and plum trees , there were only 29,476 trees. Now of this last total only for one disease, the Crown Gall of the apple, there were 24,223 trees. These trees destroyed, a certificate of inspection was delivered to the 36 nurserymen who owned the trees; of which, however, four nurserymen had their certificates withheld until provision was made for the fumigation of their stock on account of San José Scale.

Perhaps it would be well to say here just how this inspection was made. While there are some diseases, such as Crown Gall and Hairy Root, that cannot be readily detected in the nursery until the stock is taken from the ground, most pests can be detected easily in the rows while the trees are growing. It is not practicable, nor necessary, to examine every tree that is growing therein. Enough should be examined, however, so that an inspector feels satisfied that certain pests or diseases do or do not occur. Probably the best way to examine a block of trees to accomplish this is to cross the rows in each block for its entire width, a number of times, each time at a different place. The places selected for crossing may be chosen by the general appearance of the block and what it is thought is liable to occur there. Ordinarily, rows should be crossed every forty or fifty feet. The inspector should move slowly and look at trees on each

side of him. In this way a great many trees will be examined while crossing a block.

This question of nursery inspection is a very important one both to the fruit-grower and to the nurseryman. But at the same time great care must be taken in the wording of laws that no unjustified prejudice or harm be done to the nursery trade; there must be some entente among the officials of the Government and members of the nursery trade. If not, sometimes quarantine laws and inspection laws may give no end of trouble.

Now to give you an idea of what is going on in the States, I may say that the Legislative Committee of the American Association of Nurserymen made ten trips to Washington in the last six years and has accomplished a lot of work in the remodeling of the Federal laws relating to the importation of all foreign stock and seedlings, which in many lines constitute the raw stock or basis of operations and production in the nursery line. Do you know that the original Federal law contained a provision that all imports should be inspected on the docks at port of entry? Think of a single steamer bringing into New York 2,000 cases of French Seedlings, all of which were to be inspected on the docks, there, where they have no facilities for this work, no experienced man for the repacking of the stock, meaning that all shipments would be delayed, abused and when they were finally released and reached the nurserymen, the vitality of the stock and seedlings would be greatly impaired. Now, the shipments, as in Canada, come right through to destination without delay and are there inspected as they should be.

Therefore, it is my humble suggestion that a committee of three members of this Society be named to look over any suggestion of a Provincial law relative to the destruction or prevention of insects or diseases in the nursery or orchard. This committee could have a hearing before the passing of such a law and anything detrimental may thus be averted in time.

THE CONTROL OF POTATO DISEASES.

H. T. Gussow, Dominion Botanist.

It is a difficult matter to give an actual estimate of the annual losses for the Dominion, due to plant diseases affecting the potato crop. Judging from the considerable number of cases, the total loss must be enormous in some years particularly.

The loss from the so-called "storage rots" amounted in some cases to 40 percent; The yield, owing to the use of diseased seed, as far as can be judged from "misses" in the fields, has been occasionally reduced by some 30 percent, and diseases affecting the growing plant may also cause considerable damage to the crop.

In order to prevent such loss and make the cultivation of potatoes more profitable, it is necessary to follow strictly certain lines laid down for the elimination of diseases, when it is reasonable to expect that the diseases will be eventually exterminated or reduced to a minimum. Any objections a farmer may have to carrying out the following suggestions will disappear when he finds from experience that their observance results in a greatly increased yield and higher profits to himself.

A. The Diseases of the Seed Tuber.**

1. The presence of the following diseases or insect pests, scheduled under the "Destructive Insect and Pest Act" of the Dominion of Canada, shall disqualify any lot of potatoes for seed purposes, viz.: Potato Canker, Powdery Scab and Potato Tuber Moth.*

Potato Canker is not known at present in Canada.

Powdery Scab occurs in the Maritime Provinces; no cases of this disease have been observed west of the Province of Quebec. In order to prevent the dissemination of this disease, all potatoes grown in the "infested area" are being officially inspected and certified before shipment.

** (Attention is here directed to Farmers' Circular No. 4 entitled "Potato Diseases transmitted by the use of Unsound Seed Potatoes," which shows the more common diseases of the potato tuber in natural colours, and which will be found useful for reference when reading these lines. Copies may be obtained free of charge from the Publications Branch, Department of Agriculture, Ottawa.)

* See Circular No. 6 entitled "Regulations under the Destructive Insect and Pest Act governing the importation, sale, shipment and exportation of the Common or Irish Potato (Solanum tuberosum L.);" for copies apply to the Dominion Botanist, Experimental Farm, Ottawa.)

The Potato Tuber Moth is not known to occur in Canada. Information concerning same may be secured by writing to the Dominion Entomologist, Department of Agriculture, Ottawa.

2. Potatoes entirely free from all diseases or blemishes are the ideal potatoes for seed purposes.

3. When selecting potatoes for planting, all bruised, decayed, externally diseased or unsound tubers should be removed.

4. Tubers showing Common Scab should, preferably, be all removed. The chances are that scabby seed will produce a scabby crop.

5. After having removed all externally diseased and otherwise injured tubers, the seed should be soaked in bags or bulk for three hours in a solution of bichloride of mercury, one part in 2,000 parts of water. After treatment, spread out and dry. (See Note 1).

6. When dry, cutting the potatoes for "sets" will commence. Provide each person engaged with a potato knife, and keep a number of knives in a wooden pail containing a solution of 1: 1,000 bichloride of mercury.

7. The stem end of the tuber is the seat of several internal diseases. Cut a thin slice off the stem end of each potato; if perfectly sound and free from brown streaks, rings or spots, continue cutting it up to required size.

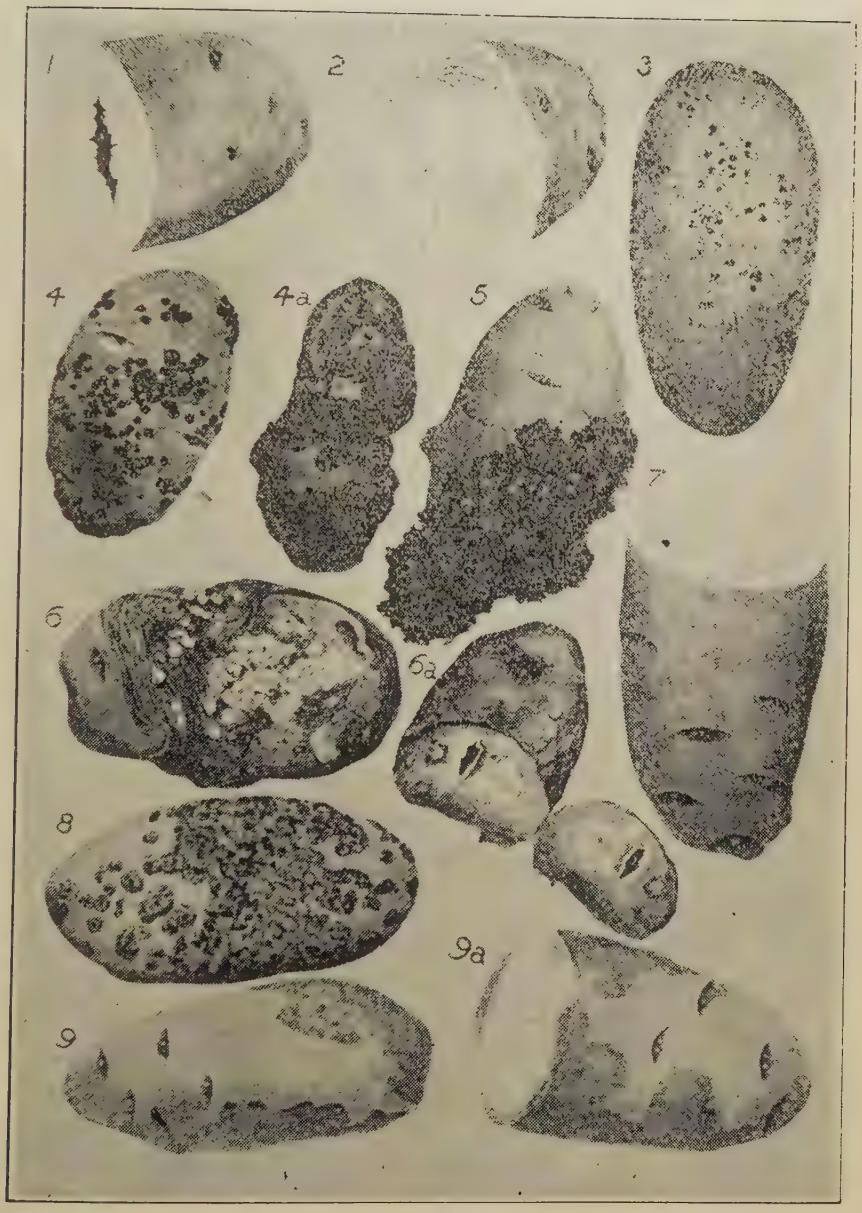
8. Discard at once all tubers showing discolouration, when cut as above, at the stem end, and throw out those showing any kind of spotting inside, though the stem end itself may have shown no disease.

9. Having used the knife on a tuber showing any kind of discolouration inside, throw it at once into the disinfecting solution, and take out another knife before cutting up a new tuber. A knife that has cut through a diseased tuber conveys certain diseases to the new tuber, hence it is very important to change the knife after having thrown out a diseased tuber. It is waste of time to cut out brown spots and use the rest of the tuber.

After following these precautions, everything has been done to eliminate diseases conveyed by unsound seed potatoes. The sets are now ready for planting.

B. Disease-Infected Land.

In the case of Powdery Scab and a number of other potato diseases, the causal organism persists in the soil for a number of years; it is, therefore, necessary to avoid too frequent succession of potato crops. Ordi-



Diseases affecting Potatoes

1. "Hollow potato"—A physiological trouble; 2. Internal brown streak—A physiological trouble; 3. Little potato disease or Rhizoctonia; 4, 4a. Powdery scab of potatoes; 5. Potato canker; 6, 6a. Dry rot of potato; 7. Stem-end rot; 8. Common potato scab; 9, 9a. Late blight of potatoes.

narily potatoes should not be grown oftener on the same land than every fourth year. Where Powdery Scab has existed, it is advisable to change to land that has not previously produced a diseased crop of potatoes. The infected land may be used for any other crop with the exception of potatoes.

Stable Manure and Artificial Fertilizers in Relation to Common Scab.

From the disease point of view, stable manure should not be used for potatoes. This is likely to result in a scabby crop, which is largely averted by the use of fertilizers. When there is a lack of humus in the soil, an application of crumbled peat will be found useful. This will also retain the moisture in light soils.

C. The Diseases of the Growing Plant.

The recognition of diseases noticeable only in the growing plant will invariably be most difficult. Where doubt exists, a specimen showing the suspected trouble should be mailed to the Dominion Botanist for his advice, but, generally speaking, careful attention to the elimination of disease in the seed tubers will have largely reduced the disease affecting the growing plant. Farmers should make it a rule to immediately remove any individual hill that may show signs of yellowing, curling-up of leaves or otherwise feeble growth, as well as any individual plant with flowers of a different colour from the rest, in order to keep varieties pure.

D. Spraying.

1. Spraying is practised for two main reasons: First, to control the Colorado Beetle; and second, to control Late Blight. There are other minor reasons.

2. Experiments have shown that several solutions will destroy the Colorado Beetle, but the solution acting most rapidly is the one to use.

3. Spraying must be done thoroughly. All plants, and all parts thereof, must be well covered. A plant with one half sprayed and the other half missed will have the unsprayed part eaten off by the beetles very quickly. This will leave enough beetles to continue the pest. One spray thoroughly applied is better than several carelessly applied.

4. We recommend two special applications for beetles; one when the plants are from four to six inches high, to be followed by another from one

to two weeks later. The interval between the sprays will naturally vary according to the severity of attack. The solution we use and recommend is made up as follows:

Eight to ten ounces of Paris Green, one and a half to two lbs. arsenate of lead to forty Imperial gallons of water. (See Note 3 and 4.)

This solution adheres satisfactorily to the foliage and controls the ravages of the beetle. Spraying will generally commence towards the 1st of July.

5. After the first two applications have been made, we continue spraying regularly once every two weeks right up to harvest time, using "poisoned" Bordeaux mixture of the following composition:

Four pounds of lime, or more if necessary (See Note 5); six pounds sulphate of copper, twelve ounces Paris Green, forty Imperial gallons of water.

6. Do not spray on very windy days. Spray early in the morning, or commence two hours before sunset. Postpone spraying in unsettled weather, but spray thoroughly, particularly after a period of rain.

E. Storing Seed Potatoes.

1. Avoid all injury through careless digging.

2. Remove all bruised, damaged or frost-touched tubers before placing potatoes in storage, else decay is likely to follow.

3. Storage places should be dry, well ventilated and cool. The temperature should be uniform and not below 33° F. and not above 38° F. Store potatoes in bulk, not in barrels or bags. Providing the tubers were matured when harvested, the loss in storage, amounting sometimes to more than one-third of the crop, will be greatly, if not entirely, reduced, if the above conditions are fulfilled.

NOTES.

1. Using Bichloride of Mercury.

Bichloride of Mercury is a deadly poison. While treating or drying treated potatoes and when disposing of used solution, keep all farm animals away.

One pound of bichloride will make 200 Imperial gallons of solution. The crude bichloride of mercury dissolves very slowly. Prepared bichloride,

ensuring rapid solution, is costly. Use crude bichloride and reduce it by pounding to a fine powder, care being taken not to inhale the dust from the chemical. When one pound has been pulverized, divide it roughly into 16 equal parts. Provide as many old bottles (white glass preferable); put one part of the powder into each, and fill them up with hot water. Shake or roll them about occasionally until dissolved. The contents of each bottle added to twelve and a half gallons of water will make a solution ready for use.

Two hundred gallons of solution will suffice for the treatment of about forty bushels of potatoes.

Use solution only once. Formalin vapour and formalin solution are often recommended, but bichloride of mercury has given the best results all round.

2. Arsenate of Lead.

Use "Swift's" Arsenate of Lead; it comes in kegs in form of a soft paste. It readily dissolves with stirring.

3. Paris Green.

One pound packages are very handy. It does not dissolve, and should be held in suspension by constant agitation. Paris Green is a deadly poison.

4. Preparation of Bordeaux Mixture.

1. Shake a quantity of quick lime in one or more barrels and fill them with the paste almost to the top, keeping the lime covered with water—or the lime surface will dry up and become lumpy and interfere with straining.

2. Prepare a " stock solution" of bluestone (sulphate of copper) in such concentration that, when using one gallon of (stirred) mixture, one pound of the chemical in solution is contained therein. To do this, dissolve two pounds of sulphate of copper in two gallons of hot water, and empty the two gallons into a barrel; repeat the process until you have one or two barrels full with the "stock solution". If you take for use one gallon of "stock solution," you will have one pound of copper sulphate.

Procedure When Making 40 Gals. Spray of the Required Strength.

To make forty gallons spray, you will require six pounds of copper sulphate with an "excess" of lime, *i.e.*, an amount sufficient to prevent injury to the leaves. Therefore, have a barrel containing some thirty-

three gallons of water, and add to this six gallons of the sulphate of copper "stock solution" (or six pounds of dissolved chemical). Next, add a quantity of lime paste with a shovel and stir well until dissolved. When dissolved, use a testing fluid to ascertain excess or deficiency of lime. The "test solution" is as follows:

Half ounce potassium ferrocyanide (poison) dissolved in one half pint of water. Fill this solution into a dropping bottle.

Having added and dissolved the lime in the copper sulphate solution, as described above, stir well the contents of the barrel and allow one minute to settle, then drop a few drops of "test solution" into it. If these, on striking the surface, colour the liquid brownish, add more lime, stir until dissolved and test again; if the mixture does not change colour, the solution contains the proper amount of lime.

There is no need to add accurately four pounds of lime. Lime will vary in composition, hence the test above prescribed is better than relying upon lime by weight.

Finally, add to each forty gallons of spray, the required quantity of Paris Green, strain through brass wire cloth strainer into pump, and solution is ready for spraying. Replenish stock solutions as required.

Spray Pump.

We use a double-cylinder, two-horse sprayer, forty gallons capacity, and have found it satisfactory after careful adjustment, but there are other sprayers on the market just as good. The more pressure you use, the finer the spray, but the more solution is required.

Forty gallons of solution should spray one acre thoroughly. Spraying one acre takes from one and a quarter to one and three-quarters of an hour. Attend to the spray nozzles: keep them free from clogging.

MEDICINAL PLANTS OF QUEBEC.

John Adams, M.A., Assistant Dominion Botanist, Ottawa.

The cultivation of Medicinal Plants is a subject that has recently received a considerable amount of attention. This is partly because the collection of wild plants is unsatisfactory, owing to the ignorance of collectors in mistaking the genuine plant for a closely-allied species, and partly to the difficulty of obtaining a sufficient quantity of those plants in the wild state, for which there is a considerable demand. Further, the present war has led to a great increase in the price of certain drugs, which are normally imported from European countries. And to this might be added misleading articles of a popular nature which have appeared from time to time, pointing out the fabulous wealth which was to be secured from the cultivation of a plot of medicinal plants.

It may be well to point out at the start that the cultivation of medicinal plants is not one to be undertaken without counting the cost, else, instead of a profit being realized, it may be found that a loss has been incurred. Unlike the regular field crops, the total amount of any one medicinal plant used in commerce is comparatively small, hence overproduction and consequent lowering of price or the absence of a market altogether may easily result. Most of the work connected with the handling of drug plants is of such a nature that it must be done by hand, consequently raising the cost of production. Seeds or roots of wild plants must be collected in order to make a beginning, or must be purchased from the dealers who handle these articles, and, in most cases, two or three years or even longer will be required to mature a crop from the time of sowing the seed. The plants after collection must be carefully dried, else they will become mouldy. And finally there is the cost of packing and freight to the nearest buyer.

As regards soil, it may be stated generally that most medicinal plants may be expected to do well in a soil adapted to ordinary field crops. But it is always advisable to grow plants in soil and conditions resembling, as far as possible, those in which they grow in a wild state. For example, Ginseng, which grows naturally in leaf-mould in a forest, will not succeed if exposed to full sunlight. Nor will a plant such as peppermint, which grows in a damp or peaty soil, do well in a sandy or dry soil that may be suited for carrots or some other crop. In other cases, the presence of a considerable quantity of lime in the soil has a tendency to retard growth.

The particular part of the plant used by the drug merchant varies in different cases. Sometimes it is the root or underground stem that is used, in others the leaves, or it may be the bark or the fruit. In the subjoined list, the particular part used is indicated in each case.

It has been found by experience that the active principle, to which a drug of vegetable origin owes its value, varies in amount according to the time of year at which it is collected. Hence it is important to collect the plant or part of the plant only within the time specified.

Roots and underground stems should be collected at the end of the growing period in autumn. Barks may be collected any time during winter, but it is easier to detach them in spring when the sap begins to flow. Leaves and tops are gathered when the plant is in flower. Fruits and seeds are collected when fully ripe.

In the case of roots or underground parts of plants, these require to be dug up carefully so as not to bruise or break them. They should then be washed gently, and, if large or thick, may be sliced before drying. Roots, leaves, etc., when drying, should not, as a rule, be exposed to direct sunlight and should be protected from rain or heavy dews at night.

The prices of drug plants, as in the case of any other commodity, vary greatly and at present are higher than usual. When writing to a drug merchant for prices, a sample should be sent at the same time, and an estimate given of the quantity which the collector has at his disposal for sale.

In the following list, there is a considerable demand for those species marked with an asterisk. The others are sold in smaller quantities:

I. Plants whose Roots or Underground Stems are Used.

1. Male Fern (*Aspidium Filix-Mas Sw.*)

2. Marginal Shield-Fern (*A. marginale Sw.*) grows in rocky woods.

3. Couch-Grass or Dog Grass (*Agropyron repens* Beauv.) is a common weed of cultivated ground.

4. Skunk Cabbage (*Spathyema foetida* Raf.) grows in swamps and wet ground.

5. Sweet Flag (*Acorus Calamus* L.) grows in swamps.

*6. American White Hellebore or Indian Poke. (*Veratrum viride* Aiton.) occurs in swamps and wet woods.

7. Blue Flag (*Iris versicolor* L.) grows in marshes and wet meadows.

*8. Yellow Lady's Slipper or Yellow Moccasin Flower (*Cypripedium parviflorum Salisb.*) occurs in swampy and boggy places in woods.

9. Wild Ginger or Canada Snakeroot (*Asarum Canadense* L.) grows in woods.

*10. Yellow Dock or Curled Dock (*Rumex crispus* L.) and

*11. Broad-leaved Dock (*Rumex obtusifolius* L.) are common weeds of cultivated ground.

*12. Blue Cohosh or Papoose Root (*Caulophyllum thalictroides* Michx.) grows in woods.

*13. May Apple or Wild Mandrake (*Podophyllum peltatum* L.) occurs in heavy soil in open woods.

14. Bloodroot (*Sanguinaria canadensis* L.) occurs in rich woods.

*15. Seneca Snakeroot or Mountain Flax (*Polygala Senega* L.) grows in rocky woods.

16. Spotted Cranesbill or Alum Root (*Geranium maculatum* L.) occurs in open woods and in fields.

*17. American Ginseng (*Panax Quinquefolium* L.) occurs in woods.

18. Wild Sarsaparilla (*Aralia nudicaulis* L.) and

19. American Spikenard (*A. racemosa* L.) grow in woods.

20. Purple-stemmed Angelica (*Angelica atropurpurea* L.) grows in swamps and moist ground.

21. Black Indian Hemp (*Apocynum cannabinum* L.) occurs in gravelly or sandy soil mostly near streams.

22. Culver's Root (*Leptandra virginica* Nutt.) grows in meadows and moist woods.

*23. Dandelion (*Taraxacum officinale* Weber) is a common weed in cultivated ground.

*24. Great Burdock (*Arctium Lappa* L.) grows as a weed on waste ground. The fruits are also used.

25. Elecampane (*Inula Helenium* L.) occurs as a weed in fields and on roadsides.

II. Plants Whose Bark is Used.

26. White Pine (*Pinus strobus* L.) is a common tree. Only the inner bark is used.

27. Butternut (*Juglans cinerea* L.) occurs in rocky ground. The bark of the root only is used.

28. Sweet Birch (*Betula Lenta* L.) grows in gravelly or sandy soil.

*29. Slippery Elm or Red Elm (*Ulmus fulva* Michx.) grows in rich soil. Only the inner bark is used.

*30. Wild Black Cherry or Rum Cherry (*Prunus virginiana* L.) occurs in woods.

31. Prickly Ash or Toothache Tree (*Zanthoxylum americanum* Miller) is a shrub occurring in rocky woods and on river banks.

32. Wild Guelder Rose or Cranberry Tree (*Viburnum Opulus* L.) is a shrub and occurs in woods and along streams in low grounds.

*33. Nannyberry or Sheepberry (*Viburnum Lentago* L.) occurs in rich soil in woods and on banks of streams. The bark of the root only is used.

III. Plants Whose Leaves (and Sometimes Flowering Tops) are Used.

*34. Witch Hazel (*Hamamelis virginiana* L.) is a shrub occurring in damp woods on rocky soil. The bark is also used. The leaves are collected in autumn.

35. Hemlock (*Conium maculatum* L.) occurs on waste ground. The fruits are also used.

*36. Pipsissewa or Prince's Pine (*Chimaphila corymbosa* Pursh.) grows in dry woods.

37. Wintergreen or Checkerberry (*Gaultheria procumbens* L.) occurs in woods, especially under evergreen trees.

38. Bearberry or Kinnikinnik (*Arctostaphylos Uva-Ursi* Spreng.) occurs in dry, sandy or rocky soil.

39. Bog-bean or Buck-bean (*Menyanthes trifoliata* L.) occurs in swamps. The underground stem is also used.

*40. Peppermint (*Mentha piperita* L.) grows in wet ground. Both leaves and flowering tops are used.

*41. Spearmint (*Mentha spicata* L.) grows in wet ground. The flowering tops are also used.

42. Mad Dog Skullcap (*Scutellaria lateriflora* L.) grows in wet places. The flowering tops are used.

43. Catnip or Catmint (*Nepeta Cataria* L.) grows in rather dry situations on waste ground. The flowering tops are also used.

*44. American Pennyroyal (*Hedeoma pulegioides* Pers.) occurs in dry fields. The flowering tops are also used.

*45. Jimson Weed or Thorn Apple (*Datura Stramonium* L.) occurs on waste ground. The seeds are also used.

*46. Henbane (*Hyoscyamus niger* L.) occurs on sandy soil. The flowering tops are also used.

47. Indian Tobacco (*Lobelia inflata* L.) occurs in fields and thickets on dry soil. The tops are also used after the first fruits ripen; also the seeds.

48. Boneset or Thoroughwort (*Eupatorium perfoliatum* L.) grows on low, wet ground. The flowering tops are also used.

49. Tansy (*Tanacetum vulgare* L.) occurs on waste ground. The flowering tops are also used.

50. Horseweed or Canada Fleabane (*Erigeron Canadense* L.) is a common weed in fields and waste places. The flowering tops are also used.

51. Coltsfoot (*Tussilago Farfara* L.) occurs in wet, clayey soil. The underground stem is also used.

IV. Plants Whose Fruits (or Seeds) are Used.

*52. Juniper (*Juniperus communis* L.) occurs on dry hills. The berry-like cones are used.

*53. Hop (*Humulus Lupulus* L.) occurs in thickets and on river banks. The whole fruiting cones are used.

54. White Mustard (*Sinapis alba* L.) and

55. Black Mustard (*Brassica nigra* Koch.) both grow in fields and waste places. The seeds when ground and mixed constitute ordinary Mustard.

56. Smooth Sumach (*Rhus glabra* L.) occurs in dry soil.

57. Caraway (*Carum Carui* L.) grows on waste ground.

V. Miscellaneous Drug Plants.

58. Balm of Gilead (*Populus candicans* Ait.). It is a large tree, the resinous buds being the part used.

59. Bittersweet or Woody Nightshade (*Solanum Dulcamara* L.) is a shrub, and occurs on damp ground. The young twigs when two to three years old are collected after the leaves have fallen. The green leaves are also used.

60. American Elder (*Sambucus canadensis* L.) is a shrub growing in moist soil at low elevation. The open flowers are used.

Those who are further interested in this subject should obtain the bulletin on "Medicinal Plants and their Cultivation in Canada" (French and English) which can be had free of charge from the Publications Branch, Ottawa.

SOME SILENT INVADERS OF OUR FIELDS.

Bro. M. Victorin, of the Christian Schools, Longueuil College, P.Q.

It must be acknowledged that, in a general way, the average farmer looks rather disdainfully on the entomologist and the botanist. Both of these are, in his mind, dirty and queer-looking gentlemen, disrespectful of fences and oatfields, bound on the ridiculous task of picking weeds and catching bugs.

Truth and justice are very far from this realistic conception, and in the name of the ill-used tribe which I have the honor to represent in this meeting, I will lay a dignified protestation. The field botanist—and the entomologist as well—patrolling, shine or rain, on the edge of our fields, is the advanced guard of agriculture.

As a matter of fact, numberless hardy and well-armed plants, endowed with powerful means of adaptation to every kind of soil or climate, silently make their way to the St. Lawrence Valley. Geologists make much about the state of equilibrium to which the earth's crust is settling through the permanent weathering processes. There is something similar at work with the vegetation of the globe. The actual distribution of plants is a resultant of various ecological factors, such as climate, soil constituents, physiographical features, etc., whose action is nevertheless hindered by the limitations of the plant itself.

On the other hand, it cannot be denied that the action of man over nature has to a large extent modified the ecological equilibrium corresponding to the actual geological phase. And as this human factor is gradually increasing its stress, we must expect that the distribution of plants will continue to vary until *each* species will have reached *every* habitat where it can compete with success with the already established flora. Botanically, a weed is, therefore, nothing else than a plant, which, through the agency of man, has found a new and excellent mode of dispersal, thus gaining a foothold which it has been able to retain through special qualities of easy multiplication or great resistance.

The St. Lawrence Valley, primitively clothed with the dense northeastern forest, and now opened gradually to agriculture and industry, would present a most interesting problem in this respect: *i.e.*, to figure the flora of the country as Champlain, Hebert and Sarrasin saw it. This, we intend to attempt some day or other.

The present paper will only be a report—brief as that of a sentry should be—about "some silent invaders of our fields."

Lactuca scariola L., the Prickly Lettuce, is becoming abundant around Mount Royal. It seems useful to draw attention to this rather cumbrous weed. We do not notice it, though, on the South Shore, nor on the Lower St. Lawrence.

Lactuca Scariola (Prickly Lettuce)

Iva xanthifolia Nutt., is a sturdy Ambrosiaceae brought into Montreal, we believe, with the American coal. We have not seen it since our report in the "Naturaliste Canadien" (XL. 87, 1913). But it is to be watched, since Mr. M. L. Fernald finds it quite at home somewhere in Maine, near our borders. (Rhodora XII. 139).

Senecio vulgaris L., the Common Groundsel, we find rather sparingly around Montreal, but extremely abundant in Temiscouata County, owing to the proximity of the Maritime Provinces where it is a pernicious plant. On the Lower St. Lawrence, the conditions seem adapted to the establishment of *Senecio* since the native flora offers also: *S. aureus* L., *S. Balsamitae* Muhl., *S. discoideus* (Hook.) Britton, and the giant halophytic *S. pseudo-Arnica* Less. We have reasons to think that *Senecio vulgaris* L., is travelling northwestward.

Vaccaria Vaccaria L., Britton, one of the worst weeds of the grain fields of the West, was collected once in Longueuil, in 1912, by one of our pupils, Mr. C. Lajoie.

Galinsoga parviflora Cav. is an immigrant from Tropical America which we have already recorded in the "Naturaliste Canadien (XXXVII: 82; XXXVII: 130). It is now a pest everywhere in the gardens around Montreal. It has even invaded the edge of sidewalks in the city.

Potentilla intermedia L., is forming extensive patches in lawns at Outremont, Island of Montreal. It is an introduction from Europe *via* the Northeastern States, but like most of the Rosaceae, it is not liable to do much damage.

Tragopogon pratensis L., the wild salsify is thoroughly naturalized around Mount St. Hilaire, one of the Monteregian trap hills. There it thrives in orchards and along roadsides. We do not know it out of this limited area.

Vinca minor L., is another introduction in the orchards of St. Hilaire. It is propagated by runners, the flowers being, as can be expected, rather scanty.

Inula Helenium L., this giant weed, common in Ontario, has maintained colonies for several years around Longueuil.

Serapias Helleborine L., represents the unique feature of a naturalized Orchidaceae in this country. It has become exceedingly abundant on and around Mount Royal. The probable origin is cultivation in very early times on account of supposed medicinal properties. We can believe with some amount of certainty that it is a relic of primitive gardening on the Island, and that it has been brought by the first French settlers. *Lysimachia punctata* L., reported for a long time to occur around Annapolis (N.S.), and now naturalized in our Province as far as Temiscouata County, has probably a similar origin.

Hieracium Pilosella L. The last but not the least. It is really to be wondered that official agriculturists in this country do not seem to realize that this Hawkweed is steadily invading our Province, and will become here, as it is in the Maritime Provinces, a most noxious weed.

We have seen it in Temiscouata, though rather sparingly, during the summer of 1913; but, last summer, we were amazed to see it checking all other vegetation in some pastures at St. Raymond Co., Portneuf, in the heart of the Laurentide district. If we add that we are aware it is doing

considerable damage in the county of Beauce, where it is dreaded as much as the Orange Hawkweed (*Hieracium aurantiacum* L.) it must be admitted

Orange Hawkweed.

that *Hieracium Pilosella* L. has already gained a strong position against the Quebec farmer. In our opinion it is more than time to begin fighting seriously this pest, the best-equipped of the above-mentioned "silent invaders of our fields."

THE BROWN TAIL MOTH IN NEW BRUNSWICK.

E. H. Strickland, Field Officer, Entomological Branch, Ottawa.

The Brown Tail Moth, which is a native of Europe, was discovered in America in 1897. In this year it was found to be present in such large numbers at Somerville, Mass., that it is believed to have been in the country for about six or seven years prior to this date. In all probability it was imported upon nursery stock from France or Holland to this district, from which it has spread in all directions, and by 1910 had established itself in New Brunswick.

Brown-tail Caterpillars devouring the foliage.
From the Report of the Dominion Entomologist for 1911.

An earlier infestation on Canadian soil was, however, recorded in Nova Scotia. From its extent at this time it is certain that the moth had been present there for several years. The agency by which this infestation was effected is thought to be the schooners which ply between this coast and the infested shores of New England, and by the natural spread resulting from the flight of adult females. This infestation is being combatted with great difficulty since it was well established before it was reported and the

collection of the winter nests, which constitutes the most practical means of control, is much hampered by the old deserted orchards and large growth of seedling apple and thorn in that district.

In New Brunswick the situation is at present somewhat better, though this Province is menaced constantly by fresh migrations from adjoining States; it is dependent, therefore, to a large extent, upon the activity displayed by the officials of these States in reducing the moths in their territory.

There can be little doubt but that within a few years the moth will be present in Quebec, and for this reason the Dominion Field Officer to the Entomological Branch spends his winters in the infested area of New Brunswick so that he will be ready to apply the most up-to-date methods of control from the first appearance of the Moth in this Province. Also a scout of certain parts of Quebec likely to be infested first is made each winter.

The summer of 1913 was marked by a very large flight of moths into New Brunswick from the State of Maine, due to the fact that the prevailing wind at the time of flight was from the west.

The survey of the Province during the winter of 1913-1914 showed that over 10,000 square miles were infested, and in this area 30,000 winter nests were taken. The 1914 flight from the States was small and at this date less than 250 nests have been taken in New Brunswick, and the work is almost completed. This figure is a tribute to the thoroughness with which the winter work in 1913-1914 was accomplished under the direction of Mr. L. S. McLaine of the Dominion Entomological Branch.

Female of Brown-tail Moth laying her batch of eggs on leaf.
From the Report of the Dominion Entomologist for 1911.

The life history of the Brown Tail Moth is briefly as follows:

The white winged moths emerge in July and the female lays a mass of eggs upon the leaf of an apple, or certain other tree. This mass contains about 300 eggs, and is covered with hairs removed from a large brown

tuft which the parent bears at the apex of the abdomen. These eggs hatch early in August, and the small larvae feed gregariously upon the leaf, and sometimes on neighbouring leaves also, skeletonising them. After a few weeks they spin a strong silken nest within one or more leaves folded together. The petioles of such leaves are attached firmly to their twigs by a conspicuous felting of white silk, so that when all the normal leaves are shed by the tree these nests remain attached, with their enclosed larvae entirely protected from rain and snow, and to a large extent from wind. In the spring they emerge from their "Winter Nests" and spread over the tree, feeding till mature when they pupate among the leaves.

The winter nest offers the most easy means of combatting this pest, for if all of these be removed during the winter a district will be free from caterpillars during the ensuing summer. This method of control has been adopted by the Government of Canada as the most practical, pending the establishment of parasites and predators in sufficient numbers to constitute a natural control. The Dominion and Provincial Governments of Nova Scotia and New Brunswick have in co-operation engaged and equipped sufficient men to deal with this phase of the work in both Provinces.

In 1913-4 and again this year some 20 men were employed in New Brunswick and about 12 men in Nova Scotia, upon this work. Each man is equipped with a long pruning pole, a pair of snow shoes, and a knapsack in which he carries such personal impedimenta as he requires for a week's sojourn in the country, a road map upon which is marked the territory he is to cover, and a note book for recording the nests taken, with the name of the host plant and locality.

When the infestation is moderately light, as has been the case so far in New Brunswick, the range of host plants is limited to the following: Apple, Pear, Thorn, Elm, Cherry, Choke Cherry and Amelanchior. Although pear is the favourite food plant it is little grown and over 80 per cent of the nests are taken from apple trees. Thus the work is resolved into an inspection of every tree of the above species within the infested area. Every man has impressed upon him the fact that his value does not depend so much upon the number of nests that he takes nor the amount of territory he covers, as upon the number of nests that are not left behind after he has worked his allotted territory.

Mr. McLaine is, this year, sending crews of four men into different portions of the Province assigning to each two or more counties to work during the season. This method keeps rail fares at a minimum.

Whenever feasible each crew chooses a headquarters from week to week in some town, and the work is planned so that the men may converge upon it towards the end of the week, in order that they may get a change of linen, and that the work accomplished may be recorded and the results forwarded to Fredericton, while the work for the coming week is planned. The men are sent out in pairs as a matter of precaution, for they have to go often far from traversed roads where an accident to a solitary man might lead to serious results. These two men usually take opposite sides of a road each working his territory back to the woods, but get into touch occasionally and help each other out when the work is unevenly divided. The work proceeds with far greater ease when snowshoeing is possible. Not only is it less tiring than walking over frozen ploughed orchards, but it also aids partners in keeping in touch with each other since a glance at an orchard for tracks at once shows whether one's partner is ahead or behind.

At sunset the two men together seek a night's lodging in a convenient house, and there count over, and record, their day's takings.

Thus from day to day more and more territory is covered and the work of different crews is joined up, till before the close of the winter, it is believed that very few of the susceptible trees have escaped examination. Anyone familiar with the condition in New Brunswick will realise how difficult it would be to say that not a tree had been missed. The apple orchards in open spaces have been examined without exception as also have, probably, the seedlings that spring up along the snake fences stretching back to the woods. But there are deserted orchards now overgrown with forest growth, which are difficult to discover and difficult to examine, and there are the seedlings just within the fringe of the woods which are detected only with the greatest care. When such an orchard is heard of from inhabitants of the district, it is hunted up and its location is marked on the map carried by the man, so that in all maps of the district for use in subsequent years its presence will be indicated.

There are, besides these places, large areas which have grown up to a tangle of thorn or apple seedlings where one can move around with difficulty only, and unless there is sufficient snow on the ground it is almost impossible for one to say with certainty that the whole has been traversed.

Most of the men return to the work from year to year and have now gained an efficiency which is indicated by the results shown by a comparison of the infestation in 1913-14 notwithstanding the fresh migrations from infested districts across the "line."

A second means of control is being employed by the Government with gratifying results. This consists of the importation of parasites and predators. By an arrangement with the Federal Government of the United States, Mr. McLaine spends his summers in the vicinity of Boston

Winter nests of Brown-tail Moth.
From the Report of the Dominion Entomologist for 1911.

collecting and rearing large numbers of the parasites and predators of the Brown Tail and Gipsy Moths, which our neighbours have succeeded in importing from Europe and establishing in their country. These are sent to various places in Nova Scotia, New Brunswick, and Quebec, and it is hoped that some day they may become so thoroughly established

here that they will bring about an equilibrium in which the larvae of the Brown Tail Moth will be kept down to innocuous numbers.

Hardly less important is the system of inspection of nursery stock imported from Europe, Japan and the New England States which was established in 1909 to prevent further and more widespread distribution of this pest. During the first year of inspection 196 webs were taken from nursery stock imported from France.

In connection with this work the Destructive Insect and Pests Act was passed in 1910 which provided for the inspection of all foreign nursery stock from infested areas, and of forest products from the infested States of New England.

A further method of control which might be used, were the infestation to become very serious, is that of spraying of arsenicals, but with the insect in question the collection of winter nests offers a far cheaper method of control, and with the encouraging statistics we can look to this method as the best and cheapest means of holding this pest in check until the time when our imported parasites may take over the control with unabated vigour for all time to come.

BUTTERFLIES IN NATURE AND IN BOOKS.

Albert F. Winn, Westmount.

It has been rather difficult to select a title suitable for a paper which our President suggested that I should write for this meeting. His impression is, and I sincerely hope he is right, that there are a great many people in this Province, as well as elsewhere, who love our beautiful butterflies and wish to learn their names and all about them, but do not know what books to refer to in order to satisfy the desire for information. If this paper should catch the eye of, and be of any assistance to, at least one person its object will have been accomplished.

Of late years all the efforts of our experts have resulted in educating the public to the conviction that the only good insect is a dead insect and that the whole race of creatures possessed of six legs should be promptly dispatched according to the latest poisoning rules laid down in the reports.

We are not, or should not be, a Society for the Protection of Plants composed of ruthless annihilators of insects, but of a body of students aiming through a study of the marvellous relationships between plants and insects, between one insect and another insect, and between both insects and plants and their respective fungous diseases, to find out and publish the best means of enabling the agriculturalist and fruit-grower to keep his or her pests within reasonable bounds and so produce crops which are a credit alike to the grower and the Province. It should be scarcely necessary to state here that no native insect has ever been, or is ever likely to be completely wiped out by an intentional action of man. This statement will perhaps be a relief to those who have eyes for the beauties of Nature and see among all her marvellous productions the many brilliantly coloured butterflies which flit from flower to flower and have felt concerned lest they should all be destroyed on account of the sins of a few more or less distant relations. There is only one truthful answer possible to the question, "How can we exterminate an insect." and that is, to destroy everything it feeds upon—which is certainly a case of the "cure being worse than the disease."

Of all the various orders of insects, the butterflies are undoubtedly the most generally known by those who have eyes for the beauties of Nature. There are certain insects, mosquitoes and black flies which also attract much attention, but the usual feeling is for man to get as far from them as possible. Everyone knows what a butterfly looks like. Most

of us have passed through a time when there was an irresistible impulse to pull off one's hat and drop it carefully over the beautiful creature that had rested for a moment on a blade of grass, or was feeding on the nectar of a flower. But we did not always catch him with his pair of eyes, each composed of hundreds of facets, occupying a large portion of his head; he could see apparently above and below, in front, behind and on all sides. Outstretched from the head also was a delicate pair of thread-like organs, with a knob at the end, known as antennae, possibly organs of scent or hearing, which revealed our presence through the cracking of some stick trodden upon or by the brushing aside of some weed or branch. And even if the butterfly could not either see, hear or smell our approach, there is nothing more restless than a butterfly, and when it settles it is always a question of whether it will stay there the small fraction of a second or for several minutes before taking to its wings again. So very often it was like the Irishman and the flea "When we put our fingers on him, he wasn't there."

But let us suppose that we have got beyond the idea of chasing butterflies either for the sport there is in capturing the elusive creatures, or the more or less primitive habit of delighting to hunt and kill living things; and that we wish to learn something of their names, the wonderful lives they lead, and the relations they bear to other portions of Nature's realm. The first question that is likely to arise in studying any animal or plant is "What is its name?" That problem occurred from the very beginning; so soon as Adam began to notice the things about him we find he had to give names to the animals.

Of names for butterflies and moths, we have a scientific or Latin name just as we have for plants and birds; and for many of the commoner sorts we have also more or less familiar ones in our own language; but, unfortunately, in North America, these are apt to be confusing, for in one place a certain name may be current, while in another district the same insect will be known by a totally different name. This condition of things will pass away and the adoption of uniform common or popular names will help much to increase the interest in our insect friends. In England, I am glad to see by a book recently published*, they have a popular and distinctive name for each and every butterfly and moth found in the British Isles. There are no duplicates, which is more than can be said for the scientific specific ones, although they are not nearly such great sinners in this respect as we are in North America. I shall in so far as possible avoid going into technical names or matters as this paper is one

* Newman's.

which could easily be extended to fill up the pages of our entire report. Let no one be dissuaded from studying the butterflies and moths through the once wide-spread belief that it is necessary to kill the insects or to impale them while still alive on the longest and rustiest pin that can be found and to let them slowly die on the parlour curtains. If we wish to make a collection of butterflies, and most of those taking up this study will probably do so, it is of course necessary that a few should be killed, but this can be done instantly by poison, without giving any pain or suffering; in fact, it must be so done if we wish to have perfect specimens for future study. A butterfly caught in the field and enclosed in a tightly fitting box—don't punch holes in it—will remain perfectly quiet while being brought home, where it can be liberated and watched. It may be fed on a little sugar and water or syrup on a piece of sponge or cotton wool, the creature unrolling its tongue which was coiled up like a watch spring beneath its head, and inserting the tip in the sweets sucks up the liquid with very evident pleasure. After examining it carefully the window can be opened and away flies the butterfly. Even our friends the botanists cannot claim to be more humane.

Now to explain how to get our names and our knowledge, often two very different matters. Of course, the first source one naturally looks to is printed books, the result of others' work, and it is a good deal easier to write this paper now than it would have been say twenty years ago, for a great many books have been published lately and the cheapening of the illustrations through photographic half-tone and three colour processes have made the prices come within reach of those of ordinary means.

The first of these I would unhesitatingly recommend to anyone is Holland's "Butterfly Book", published by Doubleday and McClure, N.Y., 1898—Canadian Edition by Wm. Briggs, Toronto, at $3.00; and obtainable at any bookstore. The book contains 48 full page plates showing in natural colours and full size nearly every butterfly one is apt to come across. A companion volume by the same author, entitled "The Moth Book" illustrates the moths in the same manner; it was published in 1906 and costs $4.00. It contains 48 plates and 263 text figures. The fact that there are about 10 times as many moths known as there are butterflies prevents quite such a large percentage of these being illustrated, but most of the forms commonly met in the eastern part of this continent are shown life size in all their beautiful colours.

With these books on our table, we await the coming of spring with its flowers and butterflies. On fine days, at the end of March or beginning of April, before all the snow has disappeared, a rather large butterfly with

crimson wings, bordered with yellow, near the inner edge of which is a row of blue round or triangular spots, and a dark, almost black underside, is often seen flying about settling here and there on a warm fence or stone with wings spread out to enjoy any heat there may be. If there are any maple trees in the neighbourhood these butterflies are sure to be seen drinking the running sap, and may often be picked off the trees between the thumb and first finger.

We take one home and know it is a butterfly by the knobs at the tips of the antennae. In the moths these organs are without knobs, being either feathered or thread-like. We pick up the "Butterfly Book" and have not far to look for our friend for he is figured on the frontispiece fig. 6, *Vanessa antiopa*, the mourning cloak butterfly. We have made its acquaintance, we know its name, we now wish to know it better, so we turn to the index and are referred to page 169 which tells us the number of the plate on which the caterpillar and the chrysalis are pictured, and that the food plants of the caterpillar are willows, elm and poplars. Owing to the limitations of space, Dr. Holland's two books are very deficent in the matter of information in the text, so for further particulars we must look elsewhere.

Harris' Treatise on Insects Injurious to Vegetation is the book I would next refer to and, although now somewhat of a classic, up to the time of Holland's books, was one that was always considered as the most useful all round work to have at hand, and it will never lose its importance in the literature of the subject. Originally published in 1841, it was republished in 1842 and 1852. It was then revised and enlarged by E. L. Flint, in 1862, and a later edition appeared in 1890, New York, Orange Judd Co., publishers. I think the price is about $2.50. It contains eight plates and 275 text figures. On pages 296-298 we read that the mourning cloak butterflies pass the long winters in a torpid state in barns, hollow trees, and crevices of walls, coming out of their hiding places very early in spring. A description is given of the black spring caterpillar which lives in colonies on the willows. These caterpillars turn in due course to chrysalids which produce the beautiful fresh butterflies about the beginning of July. These in turn lay their eggs which hatch into caterpillars, eat for a while, enter the chrysalis state and produce butterflies throughout the fall. The cold weather makes them seek winter quarters and one season's history of their lives is complete, two broods in a year.

Another useful book is French's "Butterflies of the Eastern United States" published by Lippincott, Philadelphia, in 1866 at $2.00. This contains over 400 pages with 93 text figures. Pages 193-5 deal with our

butterfly and we learn that there are two varieties that may be met with, though very rarely, as this insect is very uniform in appearance, and in any case there is no other butterfly in North America which would be likely to be confused with it. Should one wish to read further about the butterfly there is the magnificent work of S. H. Scudder, "The Butterflies of New England", published in 1886, in three 4to volumes, beautifully illustrated and a perfect mine of information, dealing with the subject from every standpoint. The cost is about $75.00 which puts it out of reach of most students, but should be accessible for reference in large libraries.

Another classic work is that of W. H. Edward's, entitled, "The Butterflies of North America", also in three volumes, which appeared in parts from 1868 to 1897 and costs about $135.00. The species dealt with are illustrated by the most exquisite hand coloured plates, and the drawings of the early stages and the complete life histories have a value which can never be excelled.

There are a number of other works both ancient and modern which might be mentioned if space permitted, but we must pass on to mention the volumes which were coming out regularly in parts till the war broke out, The Macro—Lepidoptera of the World, by Adalbert Seitz. Several volumes have been completed and it is intended to include coloured figures of every known species of butterfly and the larger moths. This work, for reference purposes, will be invaluable to anyone who is deeply interested, for the plates will show a representation which no one museum in the world could exhibit.

For further information about our mourning cloak butterfly we may go through the volumes of the various entomological periodicals, Transactions of Scientific Societies and Reports of Museums and Experimental Stations. Out of many may be mentioned *The Canadian Entomologist*, the organ of the Entomological Society of Ontario, now in its 47th year; the *Entomological News* of Philadelphia; the *Journal of the New York Entomological Society*; *Psyche*; the *Transactions of the American Entomological Society*; Dr. Barne's *Contributions to North American Lepidoptera*, all of which are full of items, large or small, dealing with insects exclusively, and containing many illustrations. Other periodicals have been published for a while and have come to untimely ends, such as *Insect Life*, *Papilio*, and *Entomologica Americana*; but, though memories of the past, the information in their pages will never cease to be of value, nor the work of their contributors forgotten.

A difficulty that confronts the student with regard to periodicals is how to find among the mass of material the items that relate to any particular insect. True, each volume has its index, but to consult the indexes of 40 volumes each of three or four periodicals is no small undertaking, particularly when the generic names change so often. Fortunately in many families and genera of butterflies and moths, monographic papers have been published giving full references to the bibliography with name of author, volume and page and date of publication. Most catalogues give reference to the original description, so our labours are lightened to some extent.

From some of these periodicals we may learn about the mourning cloak butterfly: that it is to be found not only throughout North America from Dawson City to Texas, but also in Europe and through Asia to Japan; particulars are given of parasitic insects which keep it from becoming a serious pest to the trees; we also learn that the butterfly can produce an audible scratchy sound by rubbing file-like roughened parts of the wings together, and much other interesting information. But there are many things the books won't tell us, for example, why the few specimens that are taken in England never have the borders of the wings a bright yellow, but dirty white. Neither do they tell us why we find the early spring butterflies getting more and more tattered and torn as April goes by, but early in June specimens in much better condition are seen. The only book to go to is the Book of Nature, the free common property of all, written in a language we can all understand, if we will but study its pages and turn them over one at a time to find more and more to lead one on.

We are tempted out into the fields again a little later in the season, say about Victoria Day, and the clouded sulphur butterfly, *philodice*, is on the wing actively searching for clover on which the female lays her eggs for the caterpillars to feed upon. The white imported cabbage butterfly, *rapae*, hovers about the roadsides and gardens ready to attack our cabbage plants, lettuce, mignonette and nasturtiums; while the native green-veined white, *oleracea*, is more apt to be seen in clearings in the woods. Here and there also we see the black swallow-tail butterfly, *asterias*, sailing about over fields and gardens particularly where there are parsley, carrot or any umbelliferous plants that its handsome caterpillar feeds upon. These four butterflies belong to a different family from the mourning cloak, and are to be found in our books a long way from our previous acquaintances, and we are perhaps tempted to study the classification a little to see what distinguishes them. All insects have six legs

arranged in three pairs, but if you will look at the mourning cloak you will see that the front pair are not used for walking and are mere brush-like organs, so that the family to which it belongs may be termed, "the four footed butterflies." In the others we have mentioned all three pairs are equally well developed.

At the end of May also we will find around the Columbine blossoms many active little black butterflies known as "dusky skippers". These belong to another family, most of whose members come out a little later on in the season; they are reddish orange in colour and are collectively known as "skippers". They can be recognized by the manner in which the wings are held when at rest, the upper pair being raised at an angle of 45 degrees while the lower pair are stretched out nearly horizontally.

Still another family comprises the delicate blue butterflies of the early spring and midsummer, and the equally beautiful copper butterflies.

Out of many books dealing with classification we may recommend Comstock's "Manual for the Study of Insects," (Ithaca, N.Y., 1895); and Packard's, "Guide to the Study of Insects," (H. Holt, N.Y., 1883); but there is so little stability or uniformity in the matter of classification in some orders, that the beginner would do well to commence by becoming familiar with the individual species and their habits, and will quickly learn which of the other sorts met with are closely related to those already known, and need in no wise bother his head about hair-splitting distinctions between one genus and another in order to enjoy the wonders of Nature as shown in some of her most wondrous creatures. Many of the divisions are not only entirely artificial, but are absolutely unrecognized by Nature, and such being the case, I repeat, consult and study the Book of Nature and pin your faith to what you can see for yourself rather than to what you can read on the printed pages of any books made by man.

FOREST INSECT CONDITIONS IN STANLEY PARK, VANCOUVER, B.C.

R. N. Chrystal, Field Officer, Entomological Branch, Ottawa.

On a peninsula lying to the north of the City of Vancouver, B.C., ther is an area of forest land some 900 acres in extent, known as Stanley Park. The area in question is owned by the Dominion Government, and was leased to the city for park purposes a number of years ago.

Since that time this area has been rendered accessible to the public by the construction of driveways and pedestrian trails, whilst numerous

Galls of the Sitka spruce Gall Aphis, Stanley Park, Vanc.
(From Bul. 7, Div. Ent., Dept. of Agric., Ottawa)

plans for rendering the Park an attractive pleasure ground have been carried out.

Formerly the area consisted of a mixed coniferous forest; cedar, *Thuya plicata*, Douglas fir, *Pseudotsuga, mucronata* Sitka spruce, *Picea sitchensis*, and hemlock, *Tsuga heterophylla*, being the chief species; most of the present stock on the ground is second growth, however, the area having been logged over, and only a small percentage of the large trees left standing. The present coniferous forest is in most places intermixed with a considerable proportion of broad-leaved species, and these in a few localities seem to be in sole possession of the ground. A few years ago it was noticed that the coniferous trees, more especially the hemlock and the Sitka spruce, were in a very unhealthy condition, quite a number of trees being dead, and others in a dying condition.

In 1913 an enquiry was instituted; Mr. H. T. Gussow, Dominion Botanist and Mr. J. M. Swaine, Assistant Entomologist for Forest Insects, examined the area, and reported on the conditions. The facts ascertained in this preliminary enquiry were briefly these:

I. Many of the largest cedars, were found to be top-killed, which, it was stated, was due to fungus disease.

II. The Sitka spruce was found to be suffering from the attacks of a species of Gall Aphis of the genus *Chermes*, which was found to have been in large measure the cause of the death of many trees. In certain circumscribed areas an injurious bark beetle, *Dendroctonus obesus* Lec., was also found to be working havoc among the spruce. This beetle has been found to be injurious to spruce in other parts of British Columbia.

III. The hemlock in many parts of the Park had been defoliated several years in succession by the caterpillar of a geometrid moth of the genus Therina, the caterpillars and adults being seen in large numbers in the summer and fall of 1913, and in previous years.

In the summer of 1914, a closer investigation of insect conditions in the Park was undertaken, a Forest Insect Laboratory being established for the purpose. The main objects aimed at were the tracing out of the life-history of the Gall Chermes on the Sitka spruce, and the life-history of the Therina on the hemlock.

By means of cage experiments, the migration of the winged Chermes issuing from the galls on the Sitka spruce in July was traced to the Douglas fir, which fact was observed also under natural conditions, many winged forms being found on the needles of Douglas fir in the open. The subsequent life-history of the Chermes was determined almost completely,

The Hemlock Chermes, Stanley Park, Vancouver. (Original).

and the missing points will, it is hoped, be discovered this season. As it was extremely desirable to ascertain the prevalence of the injurious bark beetles, *D. obesus*, in the Sitka spruce, a survey of the whole area of the Park was undertaken to locate and mark all beetle-infested trees, in order that they might be cut down and removed as soon as was practicable.

In the course of this survey notes were taken of the general condition of the spruce and hemlock over the area; the results of which showed that a large number of spruce had died from the attack by the Gall Chermes. The hemlock in places had been killed by repeated defoliation; but in the summer of 1914 it was noted that the Therina had greatly decreased in numbers, parasitism being assigned as the probable cause; a Tachinid was found parasitilizing the larvae in considerable numbers. In the case of the smaller trees, in 1914 the injury inflicted was practically nil.

The question of remedial measures in the case of Stanley Park can be divided into three heads, Clean Culture, Artificial Control Measures, and Reforestation. Plans have been submitted for the removal of all dead and dying trees, beginning with those trees which by their condition threaten to become a source of infection for their healthy neighbours.

Artificial control in this case includes two important operations; spraying the hemlocks with lead arsenate for the control of the defoliating caterpillars, and spraying the spruce foliage with contact insecticides to check the spread of the destructive spruce gall aphis. The power sprayers now available enable us to spray foliage up to 140 feet high, when a ladder or high platform is used. If this spraying could have been done two years ago very many of the hemlocks and all the smaller spruce along the driveways might have been saved. The damage from the caterpillars is now about over, however, and the lower spruce foliage nearly all destroyed, so that spraying operations will not be undertaken for the present. Experimental spraying determined that the spruce gall aphis could be controlled very readily with kerosene emulsion and fish-oil soap mixtures.

Under the third head comes the question of the choice of species with which to replant the areas which should be cleared. Owing to its limited extent, Stanley Park lends itself admirably to the European System of artificial sylvicultural regeneration of forest areas by planting. The species which has been recommended as being the most suitable for this purpose is the Douglas fir, which is claimed to be the healthiest conifer on the Pacific Coast. Such a scheme of regeneration, if carried out intelligently, would in all probability have the effect of transforming this beautiful park once more into a living paradise of nature, instead of being a place where one may see the dead and rotting trunks of forest giants which have gone before.

SOME INSECT PARASITES OF THE BUD MOTH.

E. Melville DuPorte, Macdonald College.

During the past two seasons the bud moth has been one of the most destructive orchard pests in certain sections of this province. The writer has made observations on life history of the insect in this district and has paid special attention to the occurrence of parasites because the splendid work done in the United States and other countries on insect parasitism has shown that a more extensive knowledge of insect parasitism and a fuller elaboration of the means of applying this knowledge to the practical problems of entomology will result in rendering innocuous some of our most injurious species, or at least in greatly reducing the extent of their depredations.

Last summer I succeeded in obtaining four hymenopterous parasites from the bud moth. Through the courtesy of Dr. L. O. Howard, Chief of the U. S. Bureau of Entomology, and Mr. J. C. Crawford of the U. S. National Museum these were identified as *Pimpla* (*Itoplectes*) *conquisitor Say*, (*Microdus*) *Bassus earinoides Cress.*, *Opius* (*Biosteres*) *sp.*, and *Pentarthron minutum Riley* (*Trichogramma pretiosa* Riley).

Of these *Microdus earinoides* is the only one which has previously been described as a parasite of the bud moth.

Pimpla conquisitor is a common parasite of wide distribution. It is one of the most important enemies of the cotton worm (*Aletia argillacea*) and is also parasitic on the bagworm, tent caterpillar and other lepidoptera.

The *Opius* is probably an undescribed species.

Microdus, *Pimpla* and *Opius* were reared from the pupae.

Pentharthron minutum was reared from the eggs of the bud moth. This minute chalcid is our commonest egg parasite and preys on a large number of hosts, but has not been before described as a parasite of the bud moth. Eggs parasitised by this insect are easily recognised, as they assume a deep, shiny black colour. On breaking open the egg a yellow grub or a yellow pupa with red eyes may be seen within it. Sometimes there are two parasites within a single egg although the length of the egg does not exceed 1-30 inch. This parasite seemed to be widespread, as I found it at Abbottsford, Como, La Trappe, Baie D'Urfé, Ste. Marie and St. Annes. It is the most abundant of the parasites found, and will

very likely soon check the increase of the bud moth. From July 21st to August 3rd inclusive, I collected 1359 eggs from various orchards in Baie D'Urfé, Ste. Annes and Ste. Marie, and of this number 77 per cent showed the black discolouration indicative of the presence of *Pentharthron minutum*. As eggs parasitised shortly before being collected would not show this black colour the actual number of parasitised eggs probably exceeded 77 per cent.

If we add to this the number of pupae parasitised by the Ichneumonid and Braconid parasites referred to above, it will be seen that the parasites of the bud moth are capable of acting as an effective check to this pest.

Other parasites of Bud moth. According to Taschenberg the following occur in Europe:—*Chelonus nigrinus*, *Chelonus similis*, *Microdus rufipes*, *Mesochorus dilutus*, and *Lissonota culiciformis*.

Slingerland notes the following forms found in the United States:—*Phytodictus vulgaris Cr.*, *Pimpla sp.* (near *P. alboricta Cr.*), and *Microdus laticinctus Cr* The last named has also been reported from Canada.

THE TENT-CATERPILLARS—AN AFTERMATH.

A. F. Winn, Westmount.

I hope you will not think it is my intention to try to say anything about either these caterpillars or the moths they produce. Anyone who has read a very small proportion of the articles which have been published in magazines, pamphlets, bulletins and weekly and daily newspapers has surely been favoured with a great deal of information about their natural history and perhaps even more unnatural history, and the insects themselves will continue to visit us in varying degrees of abundance and rarity.

Looking back to 1914, we will perhaps remember, or find some notes to the effect, that these caterpillars did not do much damage about Montreal as their enemies had at last got the better of them; while the previous year, in the earlier months of their activity, they threatened to eat up all before them, their hosts rivalling, if not exceeding, those of 1912.

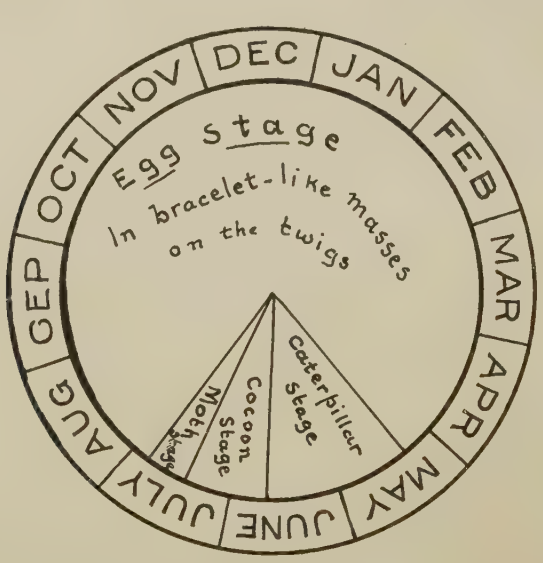


Diagram showing duration of the different stages of the Tent-Caterpillar.

Now it would be very satisfactory from a horticultural standpoint, if we could think that man could claim to have contributed, if even in a very small degree, towards ridding us of these plagues; but with all his wealth and boasted knowledge, such is not the case. It is quite true that by an almost elementary knowledge of the habits and vulnerable

points of the enemy, any careful fruit-grower can protect his own trees and slay myriads of larvae, but the effect of his labours on the numbers at large in the district would be infinitesimal. All the hope that the most learned scientists on earth could have held out to the farmer and the public a couple of years ago would have been that the raids would not recur for many years in succession, for their insect parasites and other enemies would get the upper hand before long.

The part played by insect parasites in keeping these insects within bounds is most important and must not be minimized. A thorough knowledge of these useful creatures will save enormous losses to our crops, but so far as ridding us of our last visitation of the tent-caterpillars is concerned they cannot be credited with the results. If there had not been such a thing as an insect parasite the results would have been the same.

The destroyer was a fungous or bacterial disease whose name and nature I know not, but perhaps some of our good friends at Macdonald College have been in a position to make extended studies of the disease that, towards the end of May and early June, 1913, fell upon the larvae and left nothing but their dried and shrivelled skins in myriads on the trunks and branches of the trees, those that were parasitized as well as the others all succumbing. Now comes the problem for the experimentalists. The caterpillars had only half finished their work of destroying the leaves in the woods and the trees recovered, and by the end of June the foliage looked beautiful and remained so till the fall; but when I and others who occasionally like to collect a variety of caterpillars to study their life-histories and rear in confinement long series of the beautiful moths went forth, lo and behold there were no caterpillars! Time and again we searched but instead of finding some kind every few minutes, a whole Saturday afternoon would produce perhaps three specimens. The fall web worm—that troublesome fellow which makes the ugly webs in the elms in our Montreal streets, was absent, the obliquely striped green caterpillars of the hawk-moths were absent, the large green silk-producing larvae were absent and all the other leaf-eaters were distinguished by their absence. This strange state of affairs is due to a *cause*, and I suspect the enemy of the tent caterpillars to be at the bottom of it. Can anyone tell us how long it takes for these organisms to develop to their dangerous stage? Is there more than one species, and if so, are they partial to any particular kind of larvae or are they omnivorous? During last summer and fall the scarcity of moths in their usual haunts and absence at artificial attractions such as light and sugar have been noted by all our local entomologists, and again in the fall caterpillars of all sorts were

very few and far between. How long will these conditions last? Of course, the less numerous the caterpillars, the better the farmer is pleased, and the quality of the farm products that came into the Montreal markets last fall was certainly striking evidence that the land was yielding its best results. It was a treat to see the cartloads of perfect fruit and vegetables that came into town. I cannot recollect having previously seen such uniformly good specimens. This cannot all be attributed to the absence of insect depredators. The weather, the quality of the seed, and the knowledge and experience of the grower have much to do with it; but if an insect gets in its work, the effects are usually easy to see in the marketed product. If the disease which preyed on the tent-caterpillars contributed in any degree to the conditions of the crops, we can only hope that it will continue its good work, at least as long as the European war lasts, even if we poor students of insect life have to do without a few beautiful treasures for our cabinets.

TWO BACTERIAL DISEASES OF INJURIOUS INSECT LARVAE.

E. Melville DuPorte, Macdonald College.

1. A Bacterial Disease of the Tent Caterpillar.

The tremendous devastation in our orchards, forests and woodlands caused by the tent caterpillars during the past three seasons has again brought forcibly to our minds the great economic importance of these insects. The problem of the control of injurious insects by their natural parasites is a live one at the present day, and during an overwhelming attack by any injurious form the first question one asks is, "Can it be controlled by natural means?" During normal years the tent caterpillars are kept in check by several dipterous and hymenopterous parasites. It is only when, for some reason, the numbers of these parasites become very small, that the caterpillars have a chance to increase and, owing to the large number of eggs laid, their potential increase is so great that they can in one or two seasons become as overwhelmingly destructive as they have recently been. Owing to this it is doubtful whether it would be practicable to breed and conserve a sufficient number of these parasites to be of immediate use in the control of these insects during one of their periodically recurring epidemics. We, therefore, turn our attention to infectious or contagious diseases. Can these insects be controlled by the dissemination of the germs of bacterial disease? With this question in mind last season, I tried to isolate the causal organism of a disease which has been much in evidence here among these insects and which has acted as an important factor in their control.

On June 5th I collected a number of diseased caterpillars of *Malacosoma americana*, the orchard tent caterpillar. A microscopical preparation of the diseased and disorganised tissue showed the presence, in large numbers, of a large spore bearing bacillus. Plates were made from this diseased tissue and cultures of an organism similar in appearance to that seen in the tissue were obtained and isolated. The following inoculation experiments were conducted.

1. Cage A.

June 8th.—Inoculated hypodermically 13 specimens *M. americana* with a suspension of the organism in sterile water.

June 9th.—4 caterpillars dead.

June 10th.—5 others dead (1 drowned), 1 living, 3 missing (escaped from cage).

Cage B.

June 8th.—Inoculated 10 larvae *M. disstria* as in Cage A.

June 9th.—6 caterpillars dead.

June 10th.—3 others dead, the tenth missing (escaped from cage).

Cage C. (Check).

June 8th.—Placed several larvae of both species in cage. Injected sterilised water hypodermically.

June 14th.—All caterpillars still alive and apparently healthy.

Cage D.

June 10th.—Sterilised a needle, touched culture of organism and pricked a number of caterpillars of each species.

June 11th.—All but 2 dead.

June 12th.—Another dead.

This experiment was repeated several times and in each case all or nearly all died in about 12 hours after inoculation.

Cage E. (Check).

June 10th.—Pricked several larvae with sterilised needle.

June 14th.—All alive and healthy.

The tissues of insects killed by inoculation showed the presence of the organism in very large numbers.

The above experiments show that death was not caused by the puncture of the skin or by injection of liquid, but by disease caused by the specific organism with which the larvae were inoculated and which was in the first place isolated from the tissue of diseased insects collected in the field. It should be observed that after the first isolation a large number of diseased larvae were examined from time to time and it was found that the organism under discussion was apparently not the only cause of disease as in several cases I failed to find it in the diseased tissue. In such cases death seemed to result from a protozoal disease.

Now it is readily seen that the foregoing experiments, while they establish the pathogenicity of the organism to the tent caterpillars, do

not answer the question which is of most importance to the practical agriculturist, namely: Can this disease be used as a practical means of control? That is, If the germs are sprayed on the food plants of the insect will the disease be spread? Experiments were tried to determine this, but they were not quite conclusive as will be seen from the following:—

Cage F.

June 10th.—12 tent caterpillars were put in a cage with abundance of food. The food was sprayed with a suspension of the organism in sterilised water.

June 11th.—1 dead.
June 12th.—1 dead.
June 14th.—1 dead.
June 17th.—2 dead.
June 18th.—1 dead.
June 20th.—1 dead.
June 24th.—1 dead.
June 25th.—2 dead.
June 27th.—2 dead.

It will thus be seen that all the caterpillars died within 17 days. Unfortunately, however, a few of those in the check cage died also, so that this cannot be regarded as final proof. It should be observed, however, that the majority of the checks were alive after the death of the others.

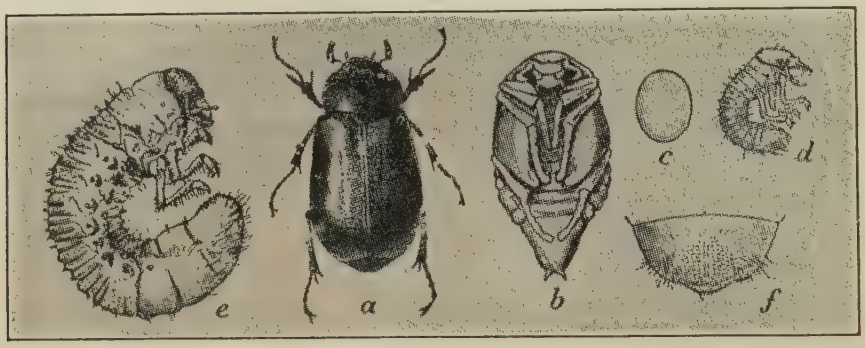
Several nests were sprayed in the field both with a pure culture and with the crushed bodies of diseased caterpillars. Though many caterpillars died in these nests, little value can be attached to these results as the wide occurrence of the disease at the time rendered doubtful any positive results obtained in the field.

It is hoped that this problem will be solved during the coming summer and also the question as to how long an artificial culture of the organism will retain its pathogenicity.

2. A Disease of the White Grub.

Professor Zae Northrup, of Michigan Agricultural College, published a bulletin last fall entitled "A Bacterial Disease of June Beetle Larvae, *Lachnosterna spp.*" In it she describes for the first time a disease caused by *Micrococcus nigrofaciens* Northrup. The knowledge of the occurrence

of this disease should be a welcome one when we consider the vast amount of injury caused by the white grubs and the difficulties attendant on the control of these insects. According to Miss Northrup the disease is widespread throughout several of the United States, occurs in Porto Rico and probably in Europe.



June Beetle and White Grub

The symptoms of the disease is a blackening of the affected area which assumes a shiny appearance. The legs are often attacked and may fall off. In dry soils death does not always occur among the diseased larvae, but the organism works rapidly in wet soils and death takes place very quickly. Miss Northrup considers that this explains the fact that the white grub injury is decidedly more marked during dry seasons.

The causal organism is a micrococcus which in microspical preparations may be arranged singly or in groups. They are usually found either in the cells of the integument or in those of the alimentary canal.

The Micrococcus is usually accompanied by a gas producing bacillus which Miss Northrup regards as being probably *B. septicus insectorum* Krassilstchik. This causes a putrefactive decomposition of the larvae which spreads rapidly. Insects affected with this organism show a brown colouration as distinct from the shiny black of *M. nigrofaciens.*

In January 1914, several months prior to the publication of Miss Northrup's work, Dr. Harrison received a culture of *M. nigrofaciens*, and photographs of diseased larvae and tissues from her. These he gave to me suggesting that it would be of interest to discover whether the organism is pathogenic to the *Lachnosterna* larvae in this vicinity. Apart from this I was interested in Miss Northrup's work, because I had previously noticed in dead white grubs a blackening of the integument re-

sembling that described by her as symptomatic of *M. nigrofaciens*. I had regarded this as due to the oxidation of the blood or some constituent of the integument.

With a view to discovering whether the organism occurs as a parasite of the white grub in our soils and also whether Miss Northrup's culture was virulent for our forms it was decided to conduct investigations on the subject. These investigations were handicapped because it was difficult to obtain a sufficient number of larvae from this vicinity. On June 5th, I obtained a white grub which was considerably blackened showing an advanced stage of the disease. It died three days later. Plates were poured and cultures of three different organisms were obtained from the diseased tissues. The most abundant was a putrefactive bacillus, possibly the one Miss Northrup found associated with *M. nigrofaciens*, and which she regards as Krassilstchik's bacillus of septicemia. A micrococcus resembling *nigrofaciens* both under the microscope and in plate culture was also isolated. Later on a few white grubs and several larvae of other scarabeidae were obtained. They were put into pots of sterilised soil. Some were sprayed with suspensions of Miss Northrup's culture, some with suspensions of the organisms isolated from the first diseased larva, others were left unsprayed as checks. This experiment was inconclusive as in most cases, including the checks, some of the larvae blackened and died while others remained healthy. They were probably infected before being put into the pots. The putrefactive organism was most in evidence, causing the tissues to break down into a disorganised foul smelling mass. In fact in several cases only the brown colour was recognised in the dead integument unaccompanied by the blackening associated with *M. nigrofaciens*. It will thus be seen that these experiments though incomplete, point towards two conclusions,—(1) that *Micrococcus nigrofaciens* is present in our soils, (2) that the putrefactive organism may cause death when not associated with *M. nigrofaciens*. I do not regard the latter conclusion as definitely proved, however, because it is possible that the putrefactive bacillus attacks the already diseased tissues and it is doubtful whether it is a primary cause of disease. If practicable further work on this subject will be conducted during the coming summer.

APPLE LEAF-SPOT OR BLACK ROT CANKER.

P. I. Bryce, Macdonald College, P.Q.

This disease, *Spaeropsis malorum*, known to many as the New York Apple Tree Canker, has been noted at Ste. Annes in two forms. First may be mentioned the Apple Leaf Spot, Brown Spot, or Frog-eye. On the upper surface of the leaves appear light brown spots with a sharply marked darker rim. The outline is circular, with a depressed light brown

Apple leaf affected with Apple Leaf-spot fungus

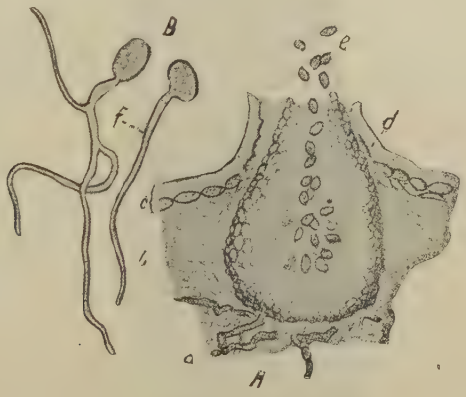
part of the spot near the centre, while the centre itself is lightly raised. The spots measure 1-8 to 1-2 inch across. The areas appear in early spring as purple flecks, and while yellow in early summer, their colour later becomes grayish. Infection of leaves takes place continuously throughout the growing season by spores shed from the "body" or branch cankers of the disease.

Effects of the Disease.

Diseased leaves drop early, so that badly infected trees are bare while the unharmed ones are in full leaf. When the leaf fall is premature the fruit is small or drops unripened. Next spring the fruit buds are weak, and the chances for a crop slight. When the leaves have fallen, the fungus on them fruits and may infect the trunk or the fruit.

Black Rot Canker.

Besides spots on the leaf, the same disease causes cankers on the limbs and Black Rot disease in the growing or stored fruit. While all three forms of the fungus cause serious losses in Quebec, the Canker does most damage. It begins as a shrunken portion of the bark, dark brown or purplish and later blackened by saprophytes. The bark may be split or cracked, and is soon roughened by numerous dots, the pycnidia, where the bark has burst open to liberate the fruit bodies of the canker.



Microscopic structure of the fruiting body of the Black Rot Fungus.

The mycelium grows in the inner and outer bark and scarcely attacks the wood. The inner bark is poisoned and digested by the fungus, and gradually dies to greater or less depth, finally shelling off and exposing the wood. The canker spreads up and down the trunk or limb, gradually girdling it. The smaller branches soon die, other parts more slowly. Through the cankers borers enter the wood, and wood destroying fungi gain a foothold in moist parts where the bark splits and lets in rain.

Infection by the Canker takes place through wounds, and probably in the spring. These injuries are commonly those from sunscald or frost-crack in winter, or when the bark is knocked off during cultivation, by climbing, at broken limbs, or where gnawed by grazing stock. The infecting spores usually come from other cankers.

Black Rot.—Black Rot, the third form of the disease, is common in New York and the Southern States, not rare in Ontario, but is scarcely

Black Rot Canker on apple branch

known in Quebec. In fruit, according to B. M. Duggar, "it is a brown rot, beginning as a small spot, frequently near the bud end of the fruit, and spreading until the whole fruit may be involved." While the fruit is attacked on the tree, the rot in fruit stored for market is one of the commonest, and speediest destroyers. The diseased fruit on the ground disseminates rot.

Varieties Attacked.—In Ontario the following varieties suffer most from canker—Ben Davis, Northern Spy, Stark, Ontario, Walbridge, Salome, Shannon and King, while the most resistant appear to be Peewaukee, Cranberry Pippin, McMahon White and Tolman Sweet. It is said that Snow (Fameuse), McIntosh and Wolfe River are immune as compared with Baldwin, Greening and Ben Davis. In New York, Esopus (Spitzenberg) is most susceptible to the Canker, then follow in order, Twenty-one Ounce, Baldwin, Wagener, Greening and King. The tenderness of some of these, notably Spitzenberg, as regards sun-scald, suggests why they are easily attacked. The fruit of Spy and Smith's Cider is sometimes severely attacked in Ohio, where Black Rot is said to be the worst decay of stored apples. In Alabama, Black Ben Davis, and Champion developed Black Rot.

Control of the Disease.—Unthrifty trees in neglected orchards suffer most. The trees, then, should be maintained at full vigour. They should be headed low, to lessen winter injury. Avoid injury to the bark during cultivation, in placing props, and when picking. Bark killed by sun-scald should be removed, the edges of the wound smoothed, disinfected with corrosive sublimate (1:1000), or copper sulphate (bluestone) 1 lb. to 10 gals. water, then painted with coal or gas tar, asphalt, or white lead in boiled oil. Large surfaces exposed by pruning are best treated similarly. Fallen or mummied apples and dead leaves ought to be destroyed or plowed under.

Spraying three times with lime sulphur and arsenate of lead is usually effective against Leaf Spot, but Bordeaux mixture 4–4–50, has been found more effective in Alabama. As Black Rot in the fruit begins usually with infection from cankers and Leaf Spot, these must be controlled. No unsound, wormy or inferior fruit should be packed with that sound and clean. After picking, the fruit should be packed at once, and placed in cold storage at 42°–32° F. temperature. The cooling before shipment, known as pre-cooling, is not always possible, but almost all growers have cool cellars where the fruit should be stored to await packing or shipment in cold cars. Keeping the packed fruit below 40° may confidently be expected to reduce or prevent Black Rot.

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SHADE TREES INSECTS IN QUEBEC.

J. M. Swaine, Assistant-Entomologist for Forest Insects, Ottawa.

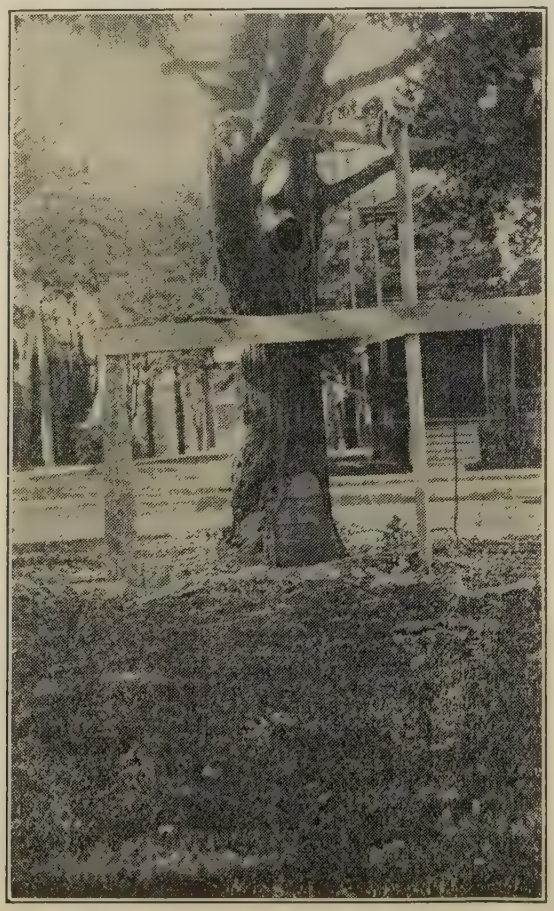
Practically all shade trees and ornamental trees grown in this Province are subject to more or less injurious attacks by insect enemies. Probably more than one-quarter of the shade trees we see are seriously injured by them, and the annual loss from this cause is very great. It is possible to control most insect attacks on trees which are valuable enough to warrant individual treatment; but very many of these injuries could be prevented by proper handling of the trees, and considerable expense and trouble could thus be avoided.

Mistakes are made often in selecting the trees for planting. Good stock should be chosen of varieties which are suited to the climate and soil conditions of the location. Trees which are likely to succumb to local insect pests should be avoided. It is almost useless, for instance, to plant the imported cut-leaf birches in districts where the Bronze Birch Borer is abundant, or the black locust tree in regions infested by the Locust Borer.

The trees should be planted carefully and properly; a good fertilizer should be applied when it is needed, and an abundance of water should be furnished to the roots in dry seasons. The weaker, unthrifty trees should receive special attention. Numbers of our bark-boring and wood-boring insects, which normally breed in dying trees, will attack trees in an unhealthy condition, particularly when the insects are present in great numbers. Other species which are notoriously destructive to healthy trees prefer weakened bark and wood and attack it most readily; this is true, particularly, of numbers of bark-beetle species. Vigorous trees in full sap are much better able to withstand the attack of some of those destructive borers, and are, of course, more likely to recover from attacks by defoliating or sucking insects or from injuries of any sort.

Protection from injuries and the proper treatment of those received are of the utmost importance. Whenever the bark is broken and left untreated, insects and fungi are almost certain to gain entrance. Many of the most serious injuries from decay originate from wounds through which the parasitic fungi enter. All such wounds should be properly cared for. Broken branches should be trimmed off even with the trunk and the bare surface coated with tar or paint. Wounds on the trunk or limbs should be cut smooth and similarly coated. Any needed prunin

should be done during the dormant period of the tree, and the stumps of the branches should be cut flush with the tree and coated with tar or good paint. Injury from wind and sleet storms can be lessened by chaining or bolting weaker upright branches together or to the trunk. Reasonable care in the prevention of injuries, and in the proper treatment of those which occur will prevent much trouble from insects and fungous rots. Trees which have been badly injured by decay can be saved in many cases by proper surgical treatment. The decayed portions should be entirely removed and the healthy surface thus laid bare disinfected with creosote or a solution of mercury bichloride. The parts should then be



A surgical operation.—The cavities cleaned, disinfected, and filled with cement. (Original.)

bolted together, if such upport is required, and the cavity filled with cement. It is best to have any important work of this kind done by an expert in tree surgery, if such services are available.

Clean Cu ture.—*All dying and dead branches and trees should be removed and burned.* Many insects and rot-causing fungi breed in such material and emerge therefrom to attack weakened or even healthy trees or branches. *It is of the utmost importance to cut out or collect all such material promptly and burn it so as to destroy the pests which it contains.* Each winter remove all dying and dead trees and parts and burn them before spring. Make it a rule to remove and burn all dying wood as soon as it is detected.

General Methods of Control.

The chief injurious insects may be grouped as defoliating insects sucking insects, and borers in the bark and wood.

Most leaf-eating insects may be controlled readily enough by the ordinary poison sprays of Paris green or lead arsenate. Very strong mixtures are at times required, and it is sometimes advisable to employ a spray of very strong contact insecticide as a more rap d control for hordes of caterpillars.

Sucking insects are controlled by spraying with strong contact insecticides such as kerosene emulsion, fish-oil soap, and good tobacco extracts.

Spraying.—The spraying of shade trees requires the insecticies and, in general, the methods employed in the spraying of orchard trees; except that we have to reach greater heights, and in such cases need a more powerful apparatus. For spraying the lower foliage the ordinary nozzles and equipment are used; but to reach the top of the higher trees it is necessary to employ a solid stream and a powerful sprayer of large capacity. A few of the power spray-pumps sold for orchard work will maintain a solid stream for 60 feet up from the nozzle; other pumps, excellent for general work in the orchard, have a small pump capacity and are unable to maintain a solid stream above 40 feet. By using a good "solid stream" nozzle, such as the Worthley, and elevating the nozzle on a platform or ladder, the average orchard power sprayer can be made fairly effective for shade-tree work. For towns and cities where large numbers of tall trees are to be sprayed a special power sprayer for shade tree purposes should be obtained. Such pumps are now available, capable of maintaining a solid stream from 80 to 100 feet up from the nozzle.

Spraying for shade tree insects should be thorough. A mist spray at high pressure should be employed for as high as the extension will reach; and for the higher portions the solid stream is necessary. The latter uses the spray mixtures very rapidly and should be employed with discretion. It is, of course, quite necessary to understand the habits of the insects to be controlled and to make the sprays at the proper time.

Hand picking is effective to a very limited extent. The tents of the American Tent Caterpillar can be removed by means of tree-trimmers or torches; egg-mases of the tent-caterpillars and the tussock moths can be removed by hand at times with profit; and the larger caterpillars, which rarely occur in great numbers, can sometimes be removed from low foliage by hand more cheaply and effectively than in any other way.

The Destruction of larger Borers.—When living trees become infested with large boring grubs or caterpillars it is necessary to kill the borers in their tunnels with the least possible injury to the trees. When the borers are near the surface it is often possible to cut them out with a knife or chisel without much injury to the wood. A wire thrust into the borings can sometimes be used effectively. It is usually possible to kill the grubs by injecting carbon bisulphide or benzine into the openings. The fluid should be injected with a syringe or oiling-can and the opening should be immediately closed with soap or putty. After several hours the holes should be opened, the grubs removed if easily reached, decaying wood cut away, the holes thoroughly syringed with strong lime sulphur or copper sulphate or with a solution of bichloride of mercury, and finally filled with cement. The carbon bisulphide or the benzine should be in jected into the flatter holes from which sap and borings have been oozing and which evidently lead to the tunnels of living larvae. It is useless to inject insecticides into the exit-holes from which the adults have escaped, although such holes should be disinfected and filled with putty or cement.

Banding the trunks of deciduous trees to prevent infestation from wandering hordes of tent caterpillars or from the wingless females of the cankerworms is often a necessary precaution. The most effective method is to make a complete girdle about the trunk with a sticky substance over which the insects cannot crawl. The adhesive should be applied in a band about four inches wide to stout paper tacked or tied about the trunk five or six feet from the ground. If the bark is eneven cotton should be placed beneath the paper to prevent the insects passing beneath. One of the best adhesives for banding is made by boiling resin and castor oil in equal parts and thoroughly mixing. The well-known preparation "Tree tanglefoot" is widely used for this purpose, and can be obtained from dealers in insecticides.

Insecticides.

Lead Arsenate.—Leaf-feeding insects of all kinds are usually best controlled by poison sprays. Lead arsenate is the best of these for shade-tree purposes; its initial cost is somewhat higher, but it adheres to the foliage longer, and does not often burn the leaves when used at the ordinary strength. It is usually sold in the form of a paste, and should be worked up in a small amount of water before being diluted. For general spraying against leaf-feeding insects, two pounds are mixed in 40 gallons of water; but for bad infestations of canker-worms, forest tent caterpillars, and certain others, especially when the caterpillars are more than one-half grown, three or four pounds to the barrel of water should be employed.

Lead arsenate is also used in the form of a powder. One pound of the powder will do the work of about two pounds of the paste.

Paris green is used at the rate of four ounces mixed in 40 gallons of water for general spraying against leaf-feeding insects. When a stronger mixture is required the poison may be increased to five ounces in 40 gallons. There must always be added twice as much freshly slacked lime as Paris green to prevent burning the foliage and the spray mixture must be kept well stirred while spraying is in operation.

Paris green	4-5 oz.
Fresh lime	½-1 lb.
Water	40 gallons.

Kerosene emulsion.—Sucking insects such as plant lice and scale insects are controlled by spraying the infested foliage with contact insecticides, which must wet the insects in order to affect them. Kerosene emulsion is generally used for this purpose.

One-half pound of hard soap is shaved fine into one gallon of hot water and stirred until dissolved. Two gallons of kerosene (coal oil) are then added and the mixture immediately churned violently until a thick creamy emulsion is produced. This churning is best done with a bucket pump, putting the nozzle back into the bucket. The stock emulsion which is obtained when the mixture is properly made will keep for months if covered from the air. For use on plant foliage it must be diluted with water at the rate of one part of the stock solution well mixed in from 9 to 12 parts of soft water.

The Stock Solution.

Laundry soap	½ pound
Soft water (hot)	1 gallon
Kerosene (coal oil)	2 gallons

The Diluted Spray.

Stock solution	1 gallon
Water	9 to 12 gallons as required

Whale-oil Soap or **Fish-oil Soap** is used for the same purposes as kerosene emulsion. It may be employed against plant lice at the rate of one pound dissolved in from four to six gallons of water. Its unpleasant odour makes this insecticide less desirable for use on shade trees.

Tobacco Extracts.—Several valuable preparations of nicotine may be obtained from dealers in insecticides. "Black Leaf 40" is one of the best of these, and is very effective in controlling plant lice. Soap should always be added to the diluted spray at the rate of about one pound to the barrel of forty gallons.

Elm leaves curled by the Elm Woolly Aphis. (Original).

The Most Important Shade Tree Insects of Quebec.

The Elm Woolly Aphis, *Eriosoma americana*, is one of the few important insect enemies of elms in Eastern Canada. These insects are small plant lice which live upon the under side of the leaves, sucking the juice and causing the edges of the leaves to curl over so that the insects are largely protected thereby. The plant-lice secrete a considerable amount of white wax threads and these colour the insects and the drops of honey dew, so abundant in the cavities of the leaves where they reside.

The pest usually becomes very numerous towards the middle or end of June and often seriously disfigures or more or less seriously injures the trees.

Control Measures.—Kerosene emulsion or fish oil soap of ordinary strength should be sprayed on the infested foliage as soon as the insects appear on the leaves and before the leaves have curled. Less success will be obtained after the leaves have become badly distorted so as to cover the insects and protect them from the spray.

The Elm Bark Louse, *Gossyparia spuria Modeer.*—The females of this species are dark red, bordered with white wax and one-tenth of an inch in length. They are usually arranged along cracks or fissures in the bark of trunks and limbs, and lie irregularly on the twigs. They suck the sap from the bark, often killing the infested branches and finally the trees. The leaves below infested limbs become coated with honey-dew and wax. The young appear in late June or early July and are most readily controlled at that time.

Control Measures.—The infested branches and trunks should be sprayed thoroughly with kerosene emulsion or fish oil soap of medium strength at the end of June, or beginning of July, while the minute young lice are crawling upon the bark; the time for spraying should be when most of the young are out of the eggs and must be determined by observation. A second application may be necessary. Lime-sulphur, winter strength, applied before the buds start in the spring is also affective.

The Forest Tent Caterpillar, *Malacosoma disstria*, is extremely abundant and injurious periodically in this Province. The caterpillars feed upon the foliage of various broad-leaf trees. The very severe outbreak of the last three years appears now to be dying out.

The caterpillar is about two inches long when full grown. The ground colour of its body is bluish or nearly black, and it has a series of conspicuous white or cream-coloured spots along the middle of the back, with two brownish-yellow bands along the upper part of each side. The row of spots along the middle of the back distinguishes this species from the American Tent Caterpillar, which has a continuous whitish band in place of the row of spots.

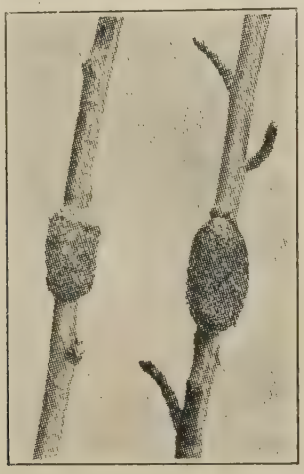


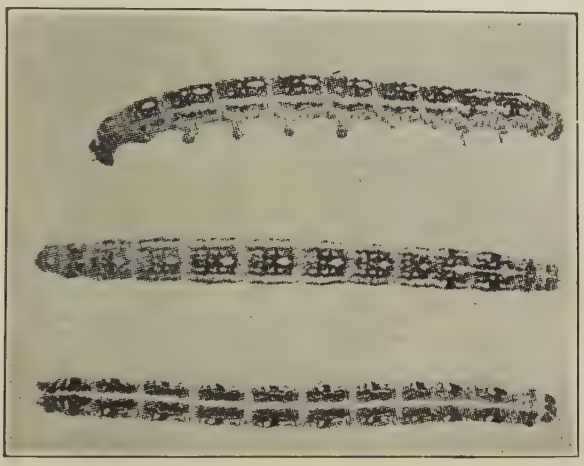
Fig. 2. Egg-masses of Tent Caterpillars: *M. americana* at the right, *M. disstria* at the left. (About natural size). [From Cir. 1, Div. Ent., Dept. Agric., Ottawa].

The caterpillars hatch in the early spring about the time the leaves appear, and feed in groups upon the foliage. They spin a fine silken thread wherever they go, but construct no tent as do their near relatives the American Tent Caterpillars of the orchard. At intervals the caterpillars of this species crowd together on a limb or on the trunk and are then quite conspicuous. The majority of the caterpillars become full grown during the latter half of June, and spin their silken cocoons in a folded leaf or other hiding place. The brownish moths appear from the cocoons during the first half of July and deposit their egg-masses on the twigs. The egg-masses are deposited in ring-like bands containing from 150 to 350 eggs embedded in a glue-like mass, usually surrounding the smaller twigs of trees upon which the caterpillars feed. They are deposited in July and remain unhatched until the following April.

Control Measures.

The control of these insects on wide areas of forest lands is not at present to be considered. The following directions apply to the protection of shade-trees, orchards, parks and wood-lots.

The Destruction of Egg-masses.—While the trees are bare of leaves the egg-masses may be very easily distinguished on the twigs. From



1, the American Tent Caterpillar; 2 and 3, the Forest Tent Caterpillar. (Slightly enlarged). From Entomological Circular No. 1, Div. Ent., Dept. Agriculture, Ottawa.

Moths of the Tent Caterpillar. *M. americana* above; *M. disstria* below; ♂, male; ♀, female. Ent. Cir. 1, Div. Ent., Dept. of Agric., Ottawa.

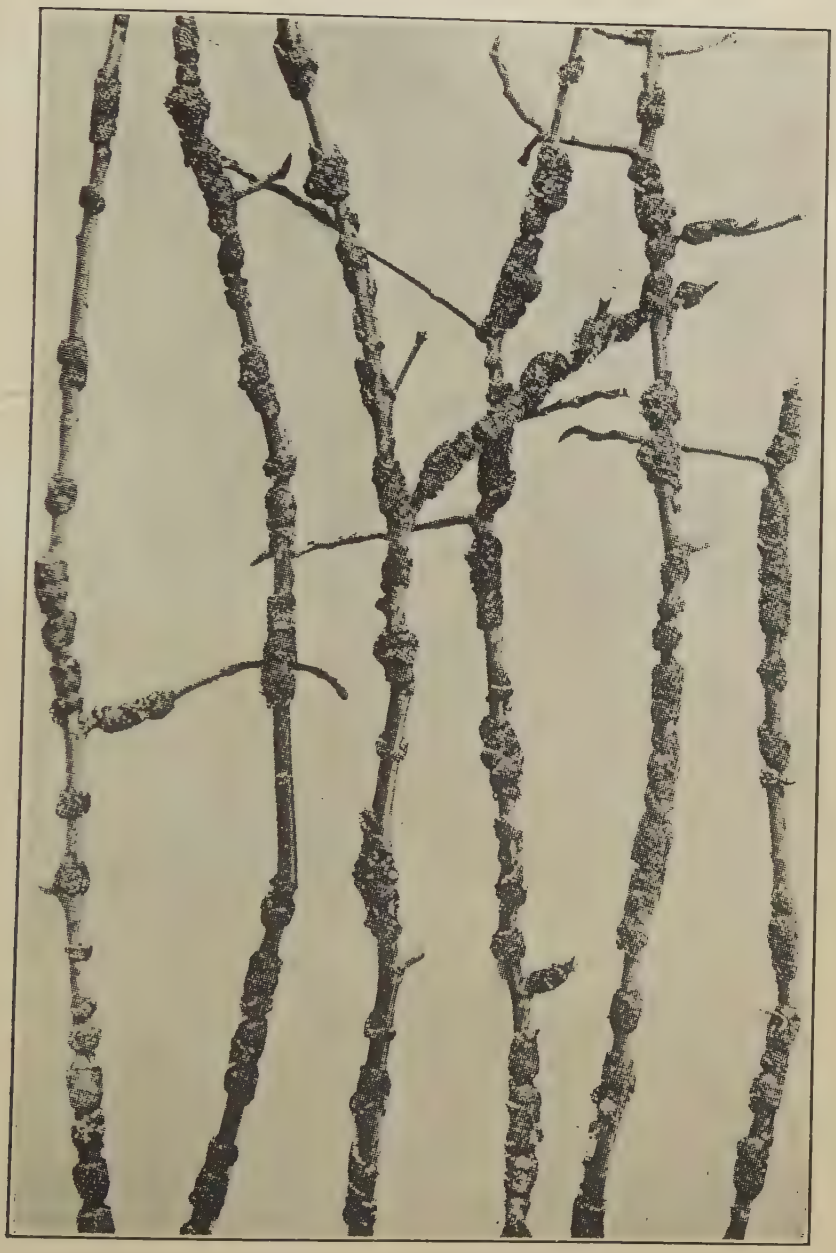
each egg-mass approximately 150 voracious young caterpillars will emerge in the following April. Much good can, therefore, be done by removing these egg-masses from small and medium-sized trees, and burning them before the first of April. This practice is profitable only on the more valuable fruit and shade trees. Ten egg-masses destroyed during the winter, rid a tree of from 1,500 to 2,500 caterpillars for the following spring. Those left may be more easily controlled.

Jarring.—The Forest Tent Caterpillar usually drops to the ground when the parts of the tree near it are jarred or shaken. By striking the branches near the clusters of caterpillars with a long-handled, padded mallet, the greater part of the caterpillars can be removed from small trees and from those of medium size. The trunks must then be banded with one of the adhesive mixtures described in the next paragraph, to prevent the creatures ascending to their old feeding grounds. It has been recommended to spread a large sheet beneath the trees before jarring, and to gather and destroy the caterpillars which fall.

Banding.—Uninfested trees frequently need to be protected from wandering caterpillars which have fallen from their original food-trees, or have been "jarred" therefrom, or are seeking new feeding grounds. These caterpillars can be prevented from climbing trees by banding the trunks, five or six feet up, with cotton, or tree tanglefoot. A band of cotton batting, eight inches wide, fastened about the trunk with a string at the middle of the band, with the upper part of the cotton turned down over the string, has been recommended as an effective obstacle to the passage of the caterpillars. It is effective only when the cotton is dry.

The most convenient band is made of some sticky substance such as tree-tanglefoot or tar. Strips of thick wrapping paper, a foot or less in width, are tied about the trunk, five or six feet above the ground, with two strings and well smeared with "tree tanglefoot," or a mixture made by boiling together equal parts of resin and castor oil. Axle grease, lard and sulphur, cottolene, and "raupenleim" are also used. The sticky substance must be renewed or extended as it dries or becomes covered with the caterpillars.

Destroying Tents and Clusters of Caterpillars.—The nests of the American Tent Caterpillar may be removed while small, and the contained caterpillars destroyed. This may be done with the aid of long-handled tree-trimmers or with a brush, or the nests may be burned with a torch while the caterpillars are within them. The torch may be made of a mass of rags or cotton waste soaked in kerosene (coal oil) and tied



Egg-masses of Tent Caterpillars on Maple Twigs. From Entomological Circular No. 1, Div. Entomology, Department of Agriculture, Ottawa.

on a long pole. Asbestos fibre soaked in kerosene and placed in a tin can nailed to the end of a pole makes an excellent torch. The flame should be passed below the nest so as to destroy it and the contained caterpillars, care being taken not to injure the bark of the branches, a rather difficult operation. The nests should, of course, be destroyed while the caterpillars are within them. The clusters of the Forest Tent Caterpillar may be removed when they are massed on the lower branches or trunks of the trees by means of a torch or by brushing them off with a stiff wire brush, or they may be killed by a strong spray of kerosene emulsion applied directly to the caterpillars.

Gathering Cocoons.—After the caterpillar stage is past and the cocoons are spun, the latter may be gathered and thus the escape of the moths which emerge will be prevented. The collected cocoons should be placed in a box covered with a coarse wire netting, about three-sixteenths of an inch mesh. This will allow the useful parasites to escape but retain the moths, which may be destroyed later.

Spraying.—When spraying apparatus is available the simplest and most convenient method is the application of Paris green in the proportion of one pound to 160 gallons of water, or lead arsenate, two pounds to 40 gallons of water, to the infested trees or parts of trees, as the caterpillars are appearing from the eggs. Orchards which receive the regular poison sprays for the codling moth and the plum curculio rarely suffer from tent caterpillars. The young caterpillars are killed by the poison before they are able to do much damage. After they are more than half grown it is much more difficult to kill them by arsenical preparations; and they should, therefore, always be attended to early in the season. When it is necessary to spray specially for these pests, it is usually sufficient to apply the mixture to the foliage on the particular branches which are attacked. Lead arsenate is perhaps to be preferred on account of its adhering qualities.

The Black Walnut Caterpillar, *Datana integerrima*, is sometimes abundant on black walnut, butternuts and other deciduous trees. The caterpillars are black when full-grown, covered with long white hairs, and become about two inches in length. They feed in large groups and sometimes cause considerable defoliation. They are easily controlled by spraying the infested branches with lead arsenate or Paris green.

The Golden Oak Scale, *Asterolecanium variolosum*, is an important enemy of cultivated oaks. It appears as a small yellow scale insect, round and strongly convex, often densely coating the twigs. The insects suck the sap and when numerous seriously weaken the trees. The young

appear late in May and early in June; a spray of kerosene emulsion or fish oil soap, made while the unprotected young are moving in the bark, is the simplest method of control.

The White Marked Tussock Moth, *Hemerocampa leucostigma* Sm. and Abb.—1, Female and egg-mass on cocoon; 2, larva; 3, adult male; 5, female pupa; 4, parasitised cocoon. 1, 3, 4 and 5 from Schoene; 2, from Riley.

The White-marked Tussock Moth, *Hemerocampa leucostigma*, is an important enemy of deciduous shade trees, particularly about cities and towns.

The caterpillar is beautifully marked, with a coral red head, a yellow band along each side, and a row of four conspicuous brush-like tufts of white or yellow hairs along the back. They hatch from the eggs late in May or early in June and at once begin feeding upon the leaves. The caterpillars frequently drop to the ground, especially from defoliated branches, and seek other trees. Towards the latter part of July the cater-

pillars pupate in cocoons attached to the bark of the trunk and branches, and about two weeks later the adult moths appear. The female is wingless and deposits her several hundred eggs in a conspicuous whitish mass upon the cocoon from which she has emerged. In this latitude the eggs mostly remain upon the trees unhatched until the following spring.

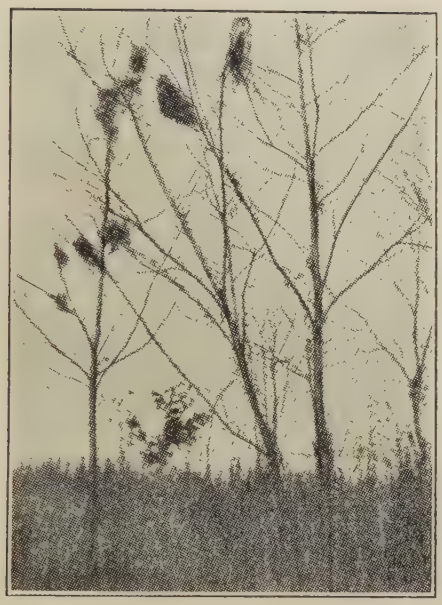
Elms and maples are our favourite city shade trees and are preferred by the tussock caterpillars, but many kinds of broad-leaf trees, including orchard trees, are attacked.

Outbreaks by these caterpillars occur periodically in Montreal and other cities and towns, usually giving rise to considerable alarm. If their ravages were allowed to increase unchecked we should lose our finest shade trees. Fortunately, the caterpillars are attacked by many insect parasites, and these useful insects usually succeed in destroying the caterpillars before the most serious injury has been caused. Nevertheless, many valuable trees suffer severely in these outbreaks, unless artificial control measures are employed.

Control Measures.—The caterpillars may be killed by spraying with lead arsenate or Paris green. The spraying should be done while the caterpillars are small, while they are more easily killed and before much of the foliage is injured. One thorough spraying should be effective unless the poison is washed off by immediate heavy rains.

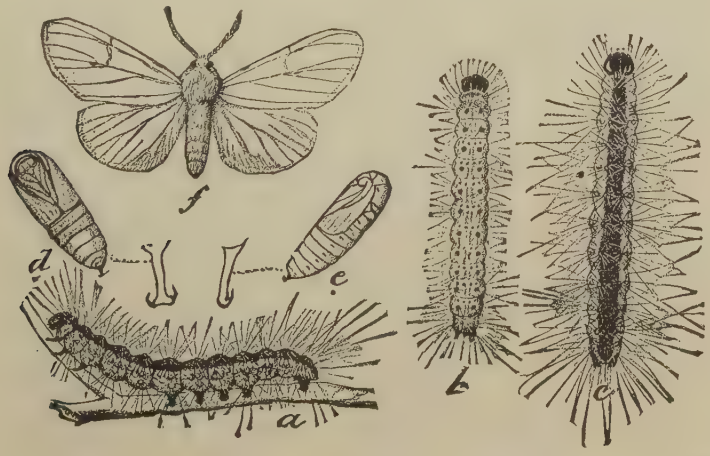
A simple and effective method is to collect and destroy the egg-masses. These are whitish and easily detected upon the bark after the leaves have fallen. Valuable parasites breed within the eggs and to avoid destroying many of these it is better to collect and burn the egg-masses in the early spring, but before the eggs hatch in May. The more valuable trees should be further protected from wandering caterpillars by banding with cotton or "tree-tanglefoot." Complete removal of the egg-masses, or thorough spraying with lead arsenate as soon as the caterpillars appear, combined with banding the trunks, will protect the trees completely.

The Fall Webworm, *Hyphantria textor*, is an annoying and sometimes rather injurious pest on elms and other broad-leaf trees. The caterpillars appear late in June or early in July and feed in colonies gradually covering the branch attacked with an irregular unsightly web. The tents of this species are readily distinguished from those of the common American Tent Caterpillars by the irregular appearance, gradually covering the leaves of a large portion of the branch, and by their presence in the latter part of the season.



Work of Fall Web Worm. (From Washburn).

Control Measures.—The tents may be removed and burned, with the caterpillars contained, while the tents are small and cover but a small portion of the branch; or the infested branches may be thoroughly sprayed with lead arsenate or Paris green.



The Fall Web Worm: a, dark colored larva from the side; c, the same from above; b, light colored larva; d, pupa from below, e, same from side. Bureau of Entomology, U. S. Dept. Agrl.

The Bronze Birch Borer, *Agrilus anxius*, is the most destructive enemy of imported white birches in parts of Eastern Canada. The adult is a rather slender brownish beetle, nearly one-half an inch in length. The grubs which cause the injury are slender whitish borers to be found excavating their tunnels in the inner bark of the trunk and branches of infested trees. The tunnels are very elongate and winding, and eventu-

White birch; the top killed by the bronze birch borer.

ally girdle and kill the parts attacked. Badly infested trees begin to die at the top, and in a few years the trees succumb. By the time the tops turn red and die the trees are hopelessly injured, and the borers can usually be found in all parts of the trunk. Their location is detected from the reddish patches on the bark caused by the oxidizing sap flowing from the borings.

Control Measures.—It is difficult to preserve imported white birches in localities where these beetles are abundant. At the first appearance of injury the infested tops and infested branches should be removed and burned before the beetles appear from the wood, late in May or early in June, to spread the infestation. After much of the top has died from the attack of the beetles, it is usually hopeless to attempt to save the tree by repeated by pruning off the dying upper portion. The whole tree is by that time a breeding ground for the pest, and if other imported birches are to be saved the badly infested trees would be much better cut and burned before the middle of May to destroy the beetles contained.

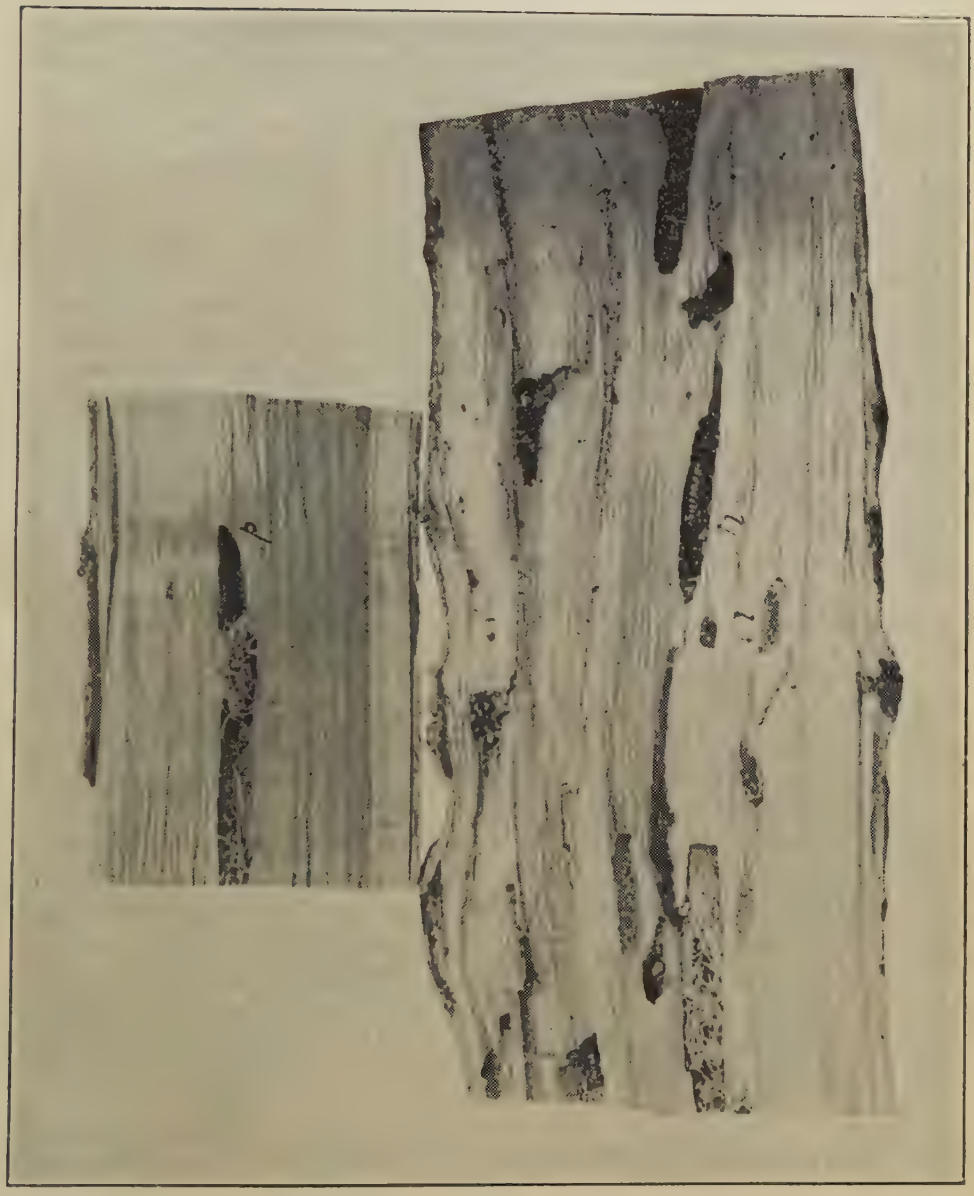
The native birches are attacked by the beetle, but are much more resistant, and injury to them is less commonly seen.

The Locust Borer, *Cyllene robiniae*, is a most destructive enemy of the black locust. The adult is a black and yellow long-horned beetle, about three-fourths of an inch in length, frequently found on the flowers of golden rod in September and later. The females deposit their eggs

Work of the locust borer, *Cyllene robiniae.*

during the fall in crevices in the bark of locust trees. The grubs cut their winding tunnels deep into the wood and upwards from the point of entrance. Many grubs may be working in the same portion of the tree, and the trunks and branches are badly distorted, killed outright, or so weakened as to be easily broken.

A poplar partly killed by the poplar borer, *S. calcarata*.



Work of the poplar borer, *S. calcarata*, in poplar: *l.* larva; *p.*, pupal cell.

Badly infested branches and trunks should be cut out and burned in winter or spring, so as to destroy the grubs contained. Some good may be done by examining the trunks and larger branches in the fall and cutting out the small grubs betrayed by the castings. It is better to select other trees for planting in localities infested by this destructive borer.

The Poplar Borer, *Saperda calcarata*, is a common and destructive enemy to poplars.

The adults emerge from the wood during the summer, and the young larvae may be found working in the bark during the autumn. The whitish larvae or grubs live within the wood for probably three years, attaining a length of nearly two inches, and drive their tunnels through the trunk in all directions. The writer has taken them from the heart-wood of the largest poplars. Rough, discoloured scars and swollen areas on the trunk and branches of poplars are frequently caused by this insect, and dying branches and portions of the trunk are a common result of its work.

Infested trees of little value should be removed and burned before June. Valuable trees may be protected in large measure by searching for the young borers in the bark, during the fall, and destroying them. The older grubs may sometimes be killed by injecting benzine or carbon bisulphide into the borings.

The Lilac borer, *Podosesia syringae*, is a common pest of lilacs. The white caterpillar bores in the base of the stem which it girdles and kills. Valuable lilacs should be examined during the early summer and any borers in the stems removed with a sharp knife and killed. The holes should be coated with tar or creosote and filled with putty. Dying stems should be removed as soon as discovered and the borers found and destroyed.

The Oak Twig Pruner, *Elaphidion villosum*, is frequently injurious in southern Quebec to twigs of oaks. The grubs excavate tunnels in the twigs causing them to break off. When the fallen twigs are very numerous the injury is more or less serious. The fallen twigs contain the grubs, and should be gathered and burned shortly after they have fallen, so that the contained grubs will be destroyed and the spread of the infestation checked.

The Carpenter Worm, *Prionoxystus robiniae*, is a large white or reddish white caterpillar with a brownish head, about 2 1-2 inches long. The adult is a large grayish moth with mottled wings. The female moth deposits eggs in crevices of the bark, and the caterpillar bores through

the bark and sapwood deep into the heart-wood, in which it excavates large more or less vertical tunnels. The caterpillar changes to a large brownish pupa which usually projects from the tunnel openings on the surface before disclosing the moth. Its work results in unsightly deformities on the trunks of the infested trees, and destructive fungi obtain entrance through its burrows. It is a serious enemy in Eastern Canada to ash, maple and black locust trees, and has been recorded also from willows, poplar, oak, elms and chestnut.

Control Measures.—The control of this insect is difficult. The best practice appears to be to trim away the roughest portions of the deformities, and then inject a sufficient amount of carbon sulphide into the borings with a syringe, and close the holes with putty or cement.

The Maple Sesian, *Sesia acerni*, is injurious to maples. The adult, a beautiful, wasp-like moth, desposits its eggs commonly about wounds on the trunk. The caterpillars are often found boring in the developing wound tissue. Large unsightly wounds and greatly weakened trees result from their work.

Control Measures.—Wounds resulting from any cause should be properly trimmed and coated with tar or grafting wax as soon as discovered. Infested trunks should be examined late in the season, the borers removed, the wounds properly smoothed and covered with tar.

The Sugar Maple Borer, *Plagionotus speciosus*, is a rather common enemy of Sugar maples in Quebec Province. The injury caused by the borers is often seen. The adult, a beautiful black and yellow beetle about an inch long, deposits its eggs in midsummer in slits in the bark of the trunk or larger branches. The legless grubs have powerful jaws and excavate shallow burrows, often several feet long, in the inner bark and sapwood. These tunnels more or less completely girdle and seriously weaken or kill the infested branches or trunks. The young grubs are betrayed in the fall by protruding "sawdust" and the tunnels of the larger borers produce unsightly scars. The grub changes to the pupa and the latter to the adult beetle in the end of the tunnel, and the beetles cut their way out through the bark by an oval hole about one-half inch in diameter. The beetles appear in June and July to deposit their eggs for the next brood. Apparently healthy trees are attacked, and dying branches and trunks as well as the scars referred to are the result of its work.

Control Measures.—Much of the injury could be averted by examining the trees in the fall and again in the spring and cutting out the

borers with a sharp knife or killing them by a wire thrust into their borings. The fresh tunnels discovered should be followed with the least cutting possible, and the borer at the end destroyed. The injury caused by the borers will eventually be more serious than the cutting necessary to remove them. The scars resulting from old tunnels should be smoothed off, and these where necessary, as well as the fresh tunnels, disinfected and filled with grafting wax or putty.

The Pine Bark Aphis, *Chermes pinicorticis*, is a most common enemy of cultivated white pines. It appears as flocculent white masses upon the green bark of the trunk and branches. Like the Spruce Gall Aphides it is not of any importance in the Province as a forest insect, but its effect upon the smaller isolated pines growing under unthrifty conditions is most marked.

The living plant lice are found upon the more tender parts of the bark sucking up the sap through their slender beaks. They secrete an immense amount of woolly wax which covers them and gives the characteristic appearance to infested trees, as though patches of fine wool had been gummed on the bark. Whenever this insect becomes very abundant, serious injury may be expected to the infested trees.

Control Measures.--Pines growing under suitable conditions are less likely to be seriously affected. It is, therefore, important to give the trees the best possible condition for growth, and one of the most important is abundance of water in dry periods. The insects may be killed by thoroughly spraying the infested portions of the trees with strong kerosene emulsion or fish oil soap late in April or during May. A second spraying may be given if needed. The spray will be more effective if the insects have been previously removed in part by a strong spray of water or by means of a stiff brush wet in very strong soap suds.

The White Pine Weevil, *Pissodes strobi*, is frequently injurious to young trees, destroying the terminal shoots, and in this way more or less distorting the shape of the trees. It is most commonly found attacking pine in Quebec, but occurs also in spruce.

The adult is a brown snout-beetle about one-fourth of an inch long, with two whitish spots on the back behind the middle. The females place the eggs under the bark, usually on the terminal shoots of young pines, in May and June. The whitish, footless grubs eat their way into the wood towards or to the pith. When the grubs are very numerous the terminal shoot is thoroughly riddled and dies towards midsummer. The adult beetles eat their way from the shoots from the end of July onwards to the middle of September.

Control Measures.—The dying tips should be cut off below the infested portion in July and left near the infested trees in boxes or barrels securely covered with window screen or wire netting. This will retain the beetles but allow the useful parasites which may be present to escape. Burning the infested shoots collected is a less desirable way of destroying the grubs.

The Spruce Gall Aphids, *Chermes similis* and *Chermes abietis*, are the most destructive enemies of cultivated spruces throughout Eastern Canada. These two species of plant lice feed in the axils of the young needles, sucking the juices. The irritat on causes an abnormal growth of the bases of the needles so that eventually a more or less cone-like gall is produced. The affected twigs are frequently killed, and many fine ornamental spruces in different parts of Quebec Province have been badly disfigured or destroyed in recent years by these two species.

Thorough spraying of the infested trees with whale-oil soap, one pound to two gallons of water, in early spring while the trees are dormant, is recommended. "Black leaf 40" at the rate of 1 to 500 has given excellent results. "Black leaf 40," 1 to 800 added to soap at the strength of one lb. to four gallons of water makes an effective spray for these pests.

The Spruce Bud-worm, *Tortrix fumiferana*, has been an important forest enemy in large areas of Quebec for some years, and has been frequently reported injuring ornamental spruces. The small caterpillars feed upon the opening buds, and later upon the needles, which they tie together with silk. The injury to many buds checks the season's growth, and the dying, partly-eaten leaves with the excrement and silk spun irregularly by the larvae give the trees a scorched appearance and detract largely from their beauty. They may be controlled by spraying with Paris green or lead arsenate.

The Spruce or Fir Saw-fly, *Lophyrus abietis*, is rather abundant locally in some seasons, and if not checked may more or less completely defoliate spruces and firs. The young are caterpillar-like saw-fly larvae about one-half an inch long, with a black head and striped dark green body. They feed voraciously upon the needles.

Sawfly larvae, or false caterpillars, of this and other species found upon cultivated spruce, fir and pine are readily controlled by spraying the infested foliage with lead arsenate or Paris green.

The Larch Case Bearer, *Coleophora laricella*, sometimes disfigures ornamental larches, and is sufficiently abundant in parts of Eastern Canada to be considered an injurious insect. It frequently precedes an outbreak

of the destructive Larch Sawfly. The larva of the Case Bearer is a tiny caterpillar of most interesting habits. The young caterpillar eats out a portion of a larch needle which it then cuts off, lines with silk, and carries about with it as a portable house covering the hinder part of its body. Leaf after leaf is then excavated by the caterpillar through a round hole cut in the side by the caterpillar to permit the entrance of its body. The caterpillars retire to the twigs before the needles drop in the fall, and pass the winter in their cases, which are firmly attached to the bark with silk.

When caterpillars are very numerous the dried and yellow skins of the excavated portion of the leaves sadly disfigure the trees, and at times an injurious loss of foliage results.

Control Measures.—The injury may be prevented by spraying trees which were badly infested the preceding season and upon which the winter cases are numerous, with lead arsenate just as the young needles are appearing in the spring, or, better, with lime sulphur, winter strength, before the growth starts in the spring. Poison sprays are not so effective later in the season, owing to the small extent of leaf surface eaten by the caterpillar; but a spray of kerosene emulsion, one of stock solution to seven parts of water, will kill a great number of them.

The Larch Woolly Aphis, *Chermes strobilobius*, is frequently abundant on cultivated larches or tamaracs. The trees sometimes appear as though covered with tiny snow-flakes, from the abundance of white wool-like wax threads covering the tiny plant lice feeding upon the leaves. The injury is seldom serious, but may weaken the trees when very abundant.

Spraying with kerosene emulsion or fish oil soap is the simplest remedy.

The Larch Saw-fly, *Lygaeonematus erichsonii*, is sometimes quite destructive to native and European larches. The caterpillar-like larvae feed upon the needles, and if numerous enough, entirely strip the trees of their foliage. Those who own valuable ornamental larches should watch for the enemy, and spray the foliage thoroughly with Paris green or lead arsenate as soon as the larvae appear, and before the foliage is much injured.

Other leaf-feeding species, such as the Spruce Saw-fly, which quite frequently strips the foliage from ornamental spruces; the Hickory Tiger-moth, common on many deciduous shade trees, and many others, are controlled by poison sprays.

The Balsam Twig Aphis, *Mindarus abietinus*, has been very abundant in Quebec for several seasons. These tiny plant lice infest the balsam

twigs in immense numbers, causing the needles to become badly curled and twisted. Many twigs are killed when the insects are very numerous, and the distorted twigs are always unsightly.

Spraying with kerosene emulsion when the trouble is first noticed, and again as required, will hold the insects in check.

A NEW BRAN MASH FOR THE CONTROL OF LOCUSTS, CUTWORMS AND ARMYWORMS.

According to the programme, Mr. Arthur Gibson, Chief Assistant Entomologist, Ottawa, who has charge of investigations on insects affecting field crops, was to have given us an account of some recent work which he conducted near Ottawa on the control of locusts, and also to speak upon the 1914 outbreak of the armyworm in Eastern Canada. Since our meeting the Entomological Branch of the Federal Department of Agriculture has published Circular No. 5, on "The Control of Locusts in Eastern Canada," and Bulletin No. 9 on "The Armyworm," both prepared by Mr. Gibson. The recently devised poison bran bait in which the juice of oranges and lemons is added as an attractant is fully described and definite results on the control of the above insects given. Both of these publications may be obtained free of charge on application to the Chief of the Publications Branch, Department of Agriculture, Ottawa. The members of our Society should make early application for these bulletins.

THE CEREAL RUSTS.

W. P. Fraser, Biology Department, Macdonald College.

The rusts are a large group of fungi which are parasitic on flowering plants and ferns. The vegetative part of the fungus consists of threads which grow in the tissues of the plants and send branches called haustoria into the cells by means of which the fungus obtains nourishment. The plant at the expense of which the fungus lives is called the host. As the mycelium lives in the tissues of the plant it is inconspicuous, but after a time spores are produced which usually break through the epidermis and appear as powdery or compact masses or crusts. Spores of five kinds may be produced, though they may not all be present in every species. These spores always follow one another in definite order. The first to appear are the spermatia which as far as is known have no function and take no part in the development or spread of the fungus. Spring spores or aecidiospores are produced next, followed later by summer spores called uredospores. Finally the teleutospores or winter spores are produced, which usually serve to carry the fungus over the winter, but in some species this is not the function of the teleutospore. Under certain conditions which vary in the different genera and species the teleutospores send out tubes and on these secondary spores called sporidia or basidiospores are produced. These, if they reach a suitable host plant start the fungus again in the spring. One or more of the spore forms may be absent in certain genera or species, but the spore succession is always the same.

Many rusts pass part of their life cycle on one plant and part on another, and usually these plants are not closely related botanically. When this is the case the spermatia and aecidiospores are produced in one host and the uredospores and teleutospores on the second. The cereal rusts belong to this two host group of rusts, though the complete life cycle of some species is not known.

The Stem Rust of Grains, (*Puccinia graminis*). This is the best known of the cereal rusts. It attacks wheat, oats, rye, barley and many grasses and is more or less common wherever these are grown.

The complete life cycle of the stem rust is as follows. In the spring the winter spores or teleutospores that have been exposed to the weather during the winter germinate by sending out a tube from each cell called a basidium and in this four secondary spores, the sporidia, are produced. These spores are carried by the wind and if they reach the barberry (Ber-

beris vulgaris) they send tubes into the young tissues, usually the leaves, and the mycelium develops there. In about a week small dot-like yellowish swellings are seen on the leaf. These are the spermagonia, flask-shaped cases which produce a large number of small spores called spermatia. As far as is known these have no function whatever. A few days later on the under side of the leaves, cup-shaped or cylindrical structures arise which contain a large number of spores in chains. These spores are yellow in colour. They are soon shed but will not attack the barberry leaves. If they are carried to grains in suitable grasses, however, they send tubes through the breathing pores into the tissues of the host. The mycelium develops rapidly among the tissues and in about ten days yellow masses of stalked spores, the uredospores, are produced on this mycelium. They break through the epidermis and appear as linear masses of loose spores which are easily carried by the wind and spread the fungus on grain during the summer. Later from the same mycelium masses of dark thick walled, two celled spores arise, the teleutospores. They rupture the epidermis and appear as dark compact linear masses which give the black appearance to the stems of the rusted grain. These spores will only germinate if exposed to the weather during the winter. When the warm spring weather comes they produce secondary spores, the sporidia, which will not infect grains as far as is known, but will attack the common barberry. The statement made in some texts that sporidia will infect grains has no evidence whatever to support it.

It is well known, however, that the stem rust persists and is abundant even in countries where the barberry does not grow, so there must be some other way in which the stem rust is carried over the winter. The uredospores are known to live through severe winters in the Northern United States, and the writer has found a very small percentage to survive Quebec winters. So it is probable that the uredospore is able to carry the fungus over the winter. The uredospores persist during the winter in the Southern United States and some of the spring infection may come from spores blown northward by the wind. It is also possible that the fungus survives the winter in the form of mycelium in grasses, and when spores are produced in the spring they may infect grains. However, it has been found that rusts do not pass readily from many grasses to grains.

It was formerly thought that the stem rust of grains (Puccinia graminis) was a single species passing readily from one kind of grain or grass to another, but infection experiments carried on in Europe and the United States have shown that though the spores in the different grains are alike in appearance yet there is a difference in infecting power.

The rusts have become adapted to certain grains, and will not grow readily on other grains or grasses, so that the stem rusts of cereals consists of a number of biologic forms as they are called.

According to experiments carried on by the United States Department of Agriculture there are the following biologic forms of the stem rust of grains in the United States:—

The Stem Rust of Wheat (*Puccinia graminis tritici*) on wheat, also attacks barley and rye sparingly.

The Stem Rust of Oats (*Puccinia graminis avenae*) on oats and some grasses.

The Stem Rust of Barley (*Puccinia graminis hordei*) on barley, also attacks wheat and rye readily.

The Stem Rust of Rye (*Puccinia graminis secalis*) on rye, also barley.

No extensive experiments have been carried out in Canada as far as the writer is aware, to determine the forms of stem rust occurring here, but is it probable that they do not differ much from those in the United States.

All of these biologic forms will pass to the barberry, but it has been found by most investigators that they behave in exactly the same manner after being transferred through the barberry as they do in the uredinial stage. With material obtained from oats growing at Ste. Annes, the writer infected barberry and trials with the uredospores thus obtained failed to infect wheat, barley and several grasses though infection was obtained readily in oats.

The stem rust is usually common on the oats and barley grown in the College farm. It is not nearly so common on wheat and rye.

The Leaf Rust of Wheat (*Puccinia rubigo-vera tritici; Puccinia triticina*) On wheat but will attack barley and rye.

The leaf rust of wheat is especially common on wheat in Eastern Canada, much more common in the writer's experience than the stem rust. The uredospore stage is more common and conspicuous than the teleutospore stage. The later stage is found in the leaves and sheath about the time the wheat is ripe, but the masses of teleutospores do not rupture the epidermis and being thus inconspicuous are often overlooked. The uredospores also occur on the leaves. There is supposed to be an aecidial stage corresponding to the stage of the stem rust in the barberry, but nothing is known of it. The Yellow Rust of Wheat (*Puccinia glumarum*) which is common and destructive in Europe and India but has

not been reported in the United States nor is it found in Canada as far as the experience of the writer goes. Some regard this rust as also a biologic form of Puccinia rubigo-vera.

The Leaf Rust of Rye (*Puccinia rubigo-vera secalis*: *Puccinia dispersa*). This species closely resembles the leaf rust of wheat in appearance, but is a biologic form as it will not attack other grains. It was found rather common on rye in the uredinal stage, but the teleutosporic stage was rarely collected. In Europe the aecidial stage is in *Anchusa officinalis* and *Lycopsis asvensis*. It may be that the European and American forms are similar though that has not yet been proved.

Leaf Rust of Oats (*Puccinia Lolii*: *Puccinia coronata*). This is a two host rust with the aecidial stage in Buckthorn species (*Rhamnus*). The uredospores and teleutospores are produced abundantly in the leaves of oats. The teleutospore masses do not break through the epidermis as in the stem rust of grains. The teleutospores can be easily recognised under the microscope as they are provided with projections at the apex, hence the rust is sometimes called the crown rust of oats.

Both stages of this rust are rather common in late sown oats in the College farm, but the early oats were not attacked. The aecidial stage in the barberry is usually present in the Buckthorn shrubs on the College campus.

The Leaf Rust of Barley (*Puccinia rubigo-vera simplex*: *Puccinia simplex*). This rust occurs on barley in the United States, but there has been no report of it in Canada as far as the writer is aware. Probably it occurs, however, and has been overlooked. It is much like the leaf rust of wheat, but the teleutospores are frequently one celled and infection experiments have shown it to be biologically distinct. The aecidial stage is not known.

Corn Rust (*Puccinia sorghi*: *Puccinia maydis*). This rust is more or less common on the leaves of corn but seems to do little damage. The aecidial stage has been known to be on **Oxalis.**

Some wheats are more resistant to the attack of rust than others. Some investigators considered that this resistance was due to morphological characters such as thick cuticle, large amount of silica, or small stomata. This view has not been confirmed, in fact there is little doubt that resistance is independent of any discernible characters in that they are of minor importance. Favourable cultural conditions do not lessen rust. In fact, the more vigorous the host, the more severe is likely to be the rust attack. So close is the relation between host and parasite, a

recent investigator claims that the acidity of the cell sap is the factor that enables plants to resist parasitic fungi. The problem of resistance is in an unsettled condition at present. It may be, however, that the problem is one of toxins in host or parasite or in both, but this is only speculation.

Control of the Rusts. Spraying experiments for the prevention of the rusts have been for the most part unsatisfactory, and even if valuable would not be practicable in large fields. Usually grain that matures early is not so severely injured as later maturing grain, so that early seeding is generally advantageous from the standpoint of rust control. The destruction of the buckthorn and barberry may help to lessen the severity of the rusts, but need not be expected to prevent their occurrence. The varieties of grain that are found by trial to be the most rust resistant should be grown.

PRINCIPAL INJURIOUS INSECTS OF THE SEASON, 1914.

W. Lochhead, Macdonald College.

The season of 1914 was a normal one and there were few insects present in startling numbers.

The following are the chief forms arranged according to their orders:--

(a) **Acarina (Mites).**—The clover mite was present on clover plants, doing some damage but not as abundant as last year.

Red Spiders.—Abundant on ornamental shrubs, and to a less extent on fruit trees.

A very large number of immature gamasids were observed attached to houseflies (*Phorbia* spp.), and many other insects. It is not certainly known whether these mites are parasitic or if they use the flies merely for transportation; but if they are parasitic (as is very probable) they must have served as a check to the increase of many flies.

(b) **Orthoptera (Grasshoppers and locusts).** Grasshoppers and locusts were quite abundant in pasture lands. Though little attention is given to these insects in this neighbourhood their numbers in certain fields were sufficiently high to cause quite appreciable injury.

(c) **Hemiptera (True bugs).**—*Green Apple Aphis* (A. **pomi**) was quite abundant and where proper control measures were not taken did considerable injury.

Woolly Aphis of Apple.—Its presence was hardly noticeable in the College orchard, but in some of the neighbouring orchards it was quite abundant.

In the early part of the season the plums were attacked by the *Plum Aphis*, but this decreased materially later on. The various aphids were partly held in check by various lady birds, syrphus fly larvae and lace-wing fly larvae which were quite abundant.

The *Oyster-shell Scale* was present on some ornamental rosaceous shrubs. The College orchards are free from it, but neighboring orchards are affected, in some cases considerably.

Leaf-hoppers on the apple were more abundant this year than in previous years, but their attack was not formidable.

The Grape-vine Leaf-hopper, which is the most prevalent insect pest of the grape here, was present as usual in large numbers, which, however, were not as great as last year.

There were large numbers of the *Buffalo Tree-hopper* this season, and as usual the omnivorous *Tarnished Plant-bug* was present in force.

Peas at the College sustained considerable injury from the *Pea Aphis*, and reports from other parts of the province show that they wrought much damage.

(d) **Lepidoptera (Moths and butterflies).**—

Cutworms—These caused considerable loss in several districts of the province. The Red-backed Cutworm (*Euxoa ochrogaster*) was most destructive. At the college, corn and roots suffered most, but several other crops were attacked.

The *Army Worm* (*Leucania unipuncta*) appeared in destructive numbers in Pontiac county in July, but through the energetic action of Mr. King, the disrict demonstrator, the losses were not great.

Imported Cabbage Butterfly was not as abundant this year as last, owing doubtless to the large number of its parasites present last year. The Diamond-back Moth (*Plutella maculipennis*) was, however, present in larger numbers than we have had for some time on turnips, and did damage.

Tent Caterpillars.—The number present this year, though formidable, was quite small as compared with last year. The ravages of a bacterial disease as well as of dipterous and hymenopterous parasites have made it practically sure that these insects will be reduced to the normal numbers next season.

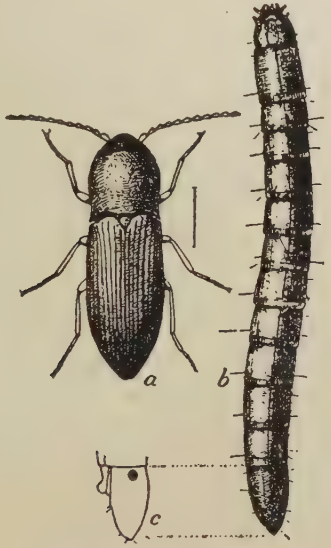
The *Bud-worm* was fairly under control in the College orchards, but in some neighbouring orchards it wrought considerable damage. Fortunately there were several parasites present of which the most important was *Pentarthron minutum* (*Trichogramma pretiosa*) which destroyed over seventy-five per cent of the eggs.

The *Cigar Case-bearer* was quite abundant in unsprayed orchards.

The *Currant span-worm* was very abundant, where spraying was omitted, on currants and gooseberries.

(e) **Diptera)Fies).**—The *Root Maggots* of onion and cabbage as well as *Phorbia fusciceps* which was found attacking turnips last year, were all present, but did not do any serious injury.

(f) **Coleoptera (Beetles).**—The *Turnip Flea-beetle* was common on crucifers during the early part of the season. The *Wavy-Striped Flea-beetle* (*Phyllotreta sinuata*) was also present on crucifers at the same time Later in the season *Systena hudsonica*, which is very common on a number of wild plants, also fed to a considerable extent on clovers, potatoes, etc.



Wheat Wireworm and Beetle

The *Raspberry Cane-borer* has been quite busy this year during its laying season, and a large number of twigs of both wild and cultivated raspberries and blackberries have been killed by its egg punctures.

(g) **Hymenoptera (Bees and wasps).**—The *Pear-tree Slug* was among the most abundant of the orchard pests during the season. The first brood did considerable injury to the cherries and plums, and the second brood promises to be still more destructive.

The *Currant Sawfly* was quite injurious to wild and cultivated currants and gooseberries.

The *Clover-seed Chalcid.*—This insect, which was observed last year for the first time doing considerable damage to the seed crop, was again present this year. A large number of larvae and pupae were obtained from the seed sown in the spring, and a large percentage of the developing seed in the field was destroyed.

Parasitic Control of Insects.

It will be observed, after a reading of the foregoing notes on the Injurious Insects of the Season, that parasitic and predaceous enemies are an important factor in their control. For example, we find that of the insects mentioned the tent caterpillar, bud-worm, cabbage-worm, plum aphis, house fly, army worm are at least partially controlled by parasites. Besides these, we know that *Perillus circumcinctus*, a predaceous bug, is making headway against the Potato Beetle in some sections, that Lady-bird beetles and Syrphid flies are working havoc to plant lice on infested plants, and that Ichneumon, Braconid and Chalcid flies levy a heavy toll on cutworms and other of the larger caterpillars.

While it is true that all or nearly all of our injurious insects have their natural enemies, which often keep them more or less under control, yet it must be acknowledged that no method of "mobilizing" these enemies at the proper time so as to do away with spraying and other devices has been discovered. The science of Entomology must advance much farther before it can prevent insect outbreaks or meet them successfully by means of their natural enemies. That progress is being made, however, is shown by the warfare against the Gypsy and Brown-tail moths, the Cottony Cushion-Scale of California, and the Black Scale of Florida.

At present the most hopeful line of control lies in the adoption of better cultural methods and in the conservation of our insectivorous birds. Cultural or Preventive methods relate to those practices of culture or of handling the crop that prevent or interfere with the development of insects. Such methods are now used against the Hessian Fly, Cotton Boll-weevil, Clover-root Borer, Wireworms, White Grubs, Cutworms including Army worms, Chinch Bug, Grasshoppers, Apple Maggot and many others of the most destructive insects. The fruit-grower, however, must depend largely upon artificial or remedial methods for the control of fruit pests. Thanks to the advent of the San José Scale, such methods have been greatly improved in the last ten years by the adoption of better insecticides and better spraying machinery.

Lessons Learned.

Quebec learned a valuable lesson this year and last from her experiences with Tent-caterpillars. Owners who neglected to spray or otherwise look carefully after their shade and orchard trees lost not only the shade of the trees but also the season's fruit. It is surprising, however, how slow the general public are to take timely measures for the protection of their

crops and trees from insects. They prefer to wait until the damage is evident—but then it is too late for effective action. Their experiences with the Potato Beetle, the Codling Worm, Grasshoppers, Horn Fly and House Fly must still be very vivid, but probably next year their attitude will remain the same as ever. A few persons, however, are converted and take action in time. This is the real hope of the situation.

INSECTS AFFECTING SHADE TREES, GREENHOUSE PLANTS, DOMESTIC ANIMALS AND THE HOUSEHOLD.

W. Lochhead, Macdonald College.

I.—Insects Affecting Shade Trees.

A.—Feeding on the Leaves.

B.—Feeding or resting under webbed tents.

C.—Hairy, yellowish, brown and black marked caterpillars feeding on leaves within webbed tents in July-Sept.; adult moths, white or black-spotted.

Fall Web Worm. (Hyphantria cunea).

CC.—Hairy black caterpillars, white stripe along middle of back, lateral white and yellow line with blue spots. Resting in silken webbed tents at angles of branches.

Orchard Tent Caterpillar. (Malacosoma americana).

BB.—Feeding free on the leaves.

C.—Adults of moths not white.

D.—Caterpillars with a broken line of white dots along back, and resting masses on sides of branches and trunks.

Forest Tent Caterpillar. (Malacosoma disstria).

DD.—Caterpillars with red heads and yellow and black tufts and pencils. Female moth wingless.

White-Marked Tussock Moth. (Hemerocampa leucostigma.

DDD.—Brownish caterpillars with blue and reddish warts; hibernating as egg-masses covered with hair; adult female moth with white wings marked with dark wavy lines, wings of male light brown.

Gypsy Moth. (Porthetria dispar).

DDDD.—"Measuring Worms" feeding in the day time in spring and early summer.

Fall Canker Worm. (Alsophila pometaria).

CC.—Adult moths white.

D.—Caterpillars reddish black with only two pairs of prolegs; with three pairs of small tubercles on back; hibernate as egg-masses of 20–100 on branches.

Snow-White Linden Moth. (Ennomos subsigniarius).

DD.—Dark brown caterpillars, with a lateral row of white hairs and bright red tubercles on 6th and 7th abdominal segments; hibernate as ¼ grown caterpillars in nests of webbed leaves on tips of trees; adult moth with a tuft of brown hairs at tip of abdomen.

Brown-Tail Moth. (Euproctis chrysorrhoea).

CCC.—Adults are Butterflies. Caterpillars large, black, red-marked and spiny, feeding in clusters on terminal branches of elm, willow, poplar.

Spiny Elm-Caterpillar. (Euvanessa antiopa).

CCCC.—Adults are beetles. Adults eating irregular circular holes in elm leaves and grubs skeletonising the under surface.

Elm-Leaf Beetle. (Galerucella luteola).

CCCCC.—Adults are Sawflies.

D.—Larvae cylindric, coiled, yellowish-white, with a black line down the middle of back, on elm, poplar, willow, etc.

Elm Sawfly. (Cimbex americana).

DD.—Larvae with jet black head and green body, each segment except second marked with double parallel bows of dark dots; feeding on larch leaves.

Larch Sawfly. (Lygaeonematus erichsonii).

AA.—Boring in trunks and branches.

B.—Adults are moths.

C.—Whitish caterpillars with distinct spots and tubercles making burrows in twigs and larger branches, which often die and project above leafy branches. Moths are white with blue and black markings.

Leopard Moth. (Zeuzera pyrina).

CC.—Large white or reddish-white caterpillars making large round irregular borings in oak, maple and locust. Moth is large, dark grey.

Carpenter Worm. (Prionoxystus robiniae).

BB.—Adults are beetles.

C.—Long-horned or cerambycid beetles.

D.—Large, fleshy, legless grub making broad shallow tunnels in sapwood of sugar-maples, often killing limbs. Adult beetle brilliantly marked with yellow and black.

Sugar Maple Borer. (Plagionotus speciosus).

DD.—A whitish hairy grub making a central burrow plugged with sawdust, and cutting off twigs of maple or oak.

Twig Pruner. (Elaphidion villosum).

DDD.—White flattened legless grubs working under the bark of elm; adult a gray beetle with red lines and black spots.

Elm Borer. (Saperda tridentata)

DDDD.—White legless grubs making large irregular channels in sapwood and inner bark of poplar; large blackened swollen scars on the surface of the trunk and limbs of affected trees.

Poplar Borer. (Saperda calcarata)

Saperda candida bores into hawthorn, mountain ash, and fruit trees, and Saperda vestita into basswood.

DDDDD.—Club-shaped grubs, making irregular ugly scars opening into burrows in black locust. Adult beetle is dull black brightly marked with golden yellow, and feeds on golden rod blossoms.

Locust Borer. (Cyllene robiniae)

CC.—Metallic wood borers or Buprestid beetles.

D.—Large-headed flattened legless grubs making shallow tunnels.

Flat-Headed Borer. (Chrysobothris femorata)

DD.—A flattened whitish grub with a large flattened head, making irregular spiral burrows in the inner bark of birch.

Bronze Birch-Borer. (Agrilus anxius)

AAA.—Sucking the juices from twigs or leaves.

B.—On the leaves.

CC.—Producing terminal galls on white and Norway spruce; branch scraggly deformed.

Spruce Gall Aphis. (Chermes similis)

CC.—Producing galls on white and Norway spruce, not terminal, pine-apple shaped.

Spruce Gall Aphis. (Chermes abietis)

BB.—On the bark.

C.—Clusters of woolly aphis.

Woolly Aphis of Elm. (Schizoneura americana)

CC.—Reddish, woolly-bordered bark-lice on under surface of elm leaves.

Elm Bark-Louse. (Gossyparia spuria)

CCC.—Cottony masses attached to brown scales on under side of twigs of soft maple, elms, etc.

Cottony Maple Scale. (Pulvinaria vitis)

CCCC.—Hemispherical reddish scales mottled with black lines on under side of branches of maples.

Terrapin Scale. (Lecanium nigrofasciatum)

II.—Insects Injurious to Greenhouse Plants.

(a).—Minute, active, white, four-winged flies living on the under side of leaves, sucking the juices; young are oval flat and greenish.

White Fly. (Aleyrodes vaporariorum)

Control.—Fumigation with hydrocyanic acid gas; spraying with whale oil soap (1½ ounces to 1 gal. water) or kerosene emulsion solution, or Black Leaf 40 and soap.

(b).—Small, soft, mealy-covered bugs, with eggs enclosed in cottony sacks.

Mealy Bugs. (Pseudococcus spp)

Control.—Wash plants with soap or tobacco solution.

(c).—Oval, flat or saddle-shaped scales, on leaves of lemons, ferns, oleanders, crotons, etc.

Soft Scale. (Lecanium hemisphericum)

(d).—Round scales on leaves and twigs of ivy, date palms, etc.

Hard Scale. (Aspidiotus spp)

Control.—Washing the plants with soap or Black Leaf 40 and soap solution.

(e).—Green plant lice, often infesting violets and sucking the juices from the leaves, checking the growth.

Green Aphis. (Myzus persicae)

(f). Black plant lice sucking the juices of chrysanthemum.

Black Aphis. (Nectarophora chrysanthemicolens)

Control.—Spray with Black Leaf 40 or Kerosene emulsion.

(g).—Red mites, spinning fine webs on under surface of leaves and sucking the juices rendering the leaves sickly yellow.

Red Spider. (Tetranychus bimaculatus)

Control.—Spraying the plants with clear water or soap solution two or three times a week.

(h).—A small maggot, causing the edges of violet leaves to curl and turn yellow.

Violet Gall-Fly. (Diplosis violicola)

Control.—Hand picking infected leaves.

(i).—A small greenish white and striped caterpillar, eating lower epidermis of leaves of chrysanthemums, cinerarias, roses, carnations, etc., and tying the leaves together.

Greenhouse Leaf-Tyer. (Phlyctaenia ferrugalis)

Control.—Hand picking infested leaves; trapping the moths, spraying leaves with arsenate of lead.

III.—Insects Affecting Domestic Animals.

Sheep.

(a).—Maggots in nostrils and in nasal sinuses, causing catarrh and staggers—deposited by 2-winged fly in June and July.

Sheep Bot-Fly. (Oestrus ovis)

Control.—Smear noses with equal parts of tar and grease.

(b).—Wool falls off and large scabs form on body, with much itching.

Sheep Scab. (Psoroptes communis)

Control.—Apply a good sheep dip.

(c).—Brownish flattened tick-like insects sucking the blood—common on lambs in spring.

Sheep Tick. (Melophagus ovinus)

Control.—"Dip" the sheep after shearing.

Cattle.

(a).—Swellings or "warbles" along the back in winter.

Ox-Warble. (Hypoderma lineata and H. boris)

Control.—Apply grease to the warbles when observed.

(b).—Small flies clustering on base of horns, flanks and belly of cattle in summer, causing much annoyance.

Horn Fly. (Haematobia serrata)

Control.—Spray with zenoleum or kerosene emulsion; apply fish oil and tar with rag.

(c).—Slaty-coloured sucking lice, often abundant on neck and shoulders of cattle not well looked after.

Short-Nosed Ox Louse. (Haematopinus eurysternus)

Long-Nosed Ox Louse. (Haematopinus vituli)

Control.—Black Leaf 40 (1 part to 1000 of water) or an infusion of 4 oz. stavesacre seed and 1 oz. hellebore.

(d).—"Little red lice" feeding on the rough parts of the skin and on the hairs, causing irritation—most abundant in spring.

Biting Cattle Louse. (Trichodectes scalaris)

Control.—Same as for sucking lice (c).

Horses.

(a).—Bots attached to wall of stomach—adult fly light brown, does not bite, but horse is worried. Eggs laid on hairs of legs and shoulders.

Horse Bot-Fly. (Gastrophilus equi)

Control.—Wash legs and shoulders with diluted carbolic acid every ten days to kill the eggs.

(b).—Similar to (a) but eggs are attached to hairs of lips and nostrils.

Chin Bot-Fly. (Gastrophilus nasalis)

(c).—Large black fly that flies swiftly and bites severely, giving much annoyance to horses.

Horse Gadfly. (Tabanus atratus)

Control.—Use nets on horses.

Hogs.

(a).—Gray sucking lice—often quite large.

Hog Louse. (Haematopinus urius)

Control.—Washes of diluted carbolic acid (1 to 30) or Black Leaf 40 (1 to 800), or kerosene emulsion.

Poultry.

(a).—Yellowish or reddish mites infesting hens and chicks at night; piercing their skin and sucking the blood, causing much irritation and often death.

Chicken Mite. (Dermanyssus gallinae)

Control.—Houses well aired and lighted; remove droppings and old nesting material. Clean and scrub all perches, roosts, nests, walls and floors and spray with 5 per cent cresol or with 3 parts kerosene and 1 part crude carbolic acid.

(b).—Small pale yellow active insects feeding on rough parts of skin and bases of hairs and feathers, causing much irritation.

Common Hen Louse. (Menopon pallidum)

Control.—Houses well lighted and airy; access to dust bath; dusting with insect powder.

(c).—Minute mites burrowing under the scales of foot, leg, comb and beak, producing "scaly-leg" with much irritation. Contagious.

Itch Mite. (Sarcoptes mutans)

Control.—Oil of caraway (1 part to 5 parts white vaseline) rubbed into affected parts every few days; bathing in warm soapy water and applying sulphur ointment or 5 per cent creolin or zenoleum, or vaseline and zinc ointment.

(d).–Small mites causing the feathers to break off. Contagious.

Depluming Mite. (Sarcoptes gallinae)

Control.—As for itch mite.

IV.—Insects of the Household.

Annoying the Inmates.

(a).—Slender 2-winged insects; only the females bite or pierce the skin; larvae and pupae live and stagnant water.

Common Mosquito. (Culex pipiens)

Control.—Drain pools of stagnant water, and cover rain barrels, watering troughs, etc., or add kerosene to form a scum on surface to kill the wrigglers; screen the doors and windows. A good repellent—oil of citronella, spirits of camphor and oil of cedar; bed nets.

(b).—Similar to (a) but larger and with wings spotted.

Malarial Mosquito. (Culex maculipennis)

(c).—Two-winged insects, with four black lines on thorax; they lay but do not pierce; eggs laid on manure or decaying organic matter.

House Fly. (Musca domestica)

Control.—Remove the horse manure regularly; sprinkle manure heap with borax solution; screens on doors and windows.

(d).—Similar to (c) but with six black lines on thorax, and with piercing mouthparts.

Stable Fly.—(Stomoxys calcitrans)

(e).—Compressed, wingless, long-legged insects with piercing and sucking mouth-parts, hiding in bedding and clothing; eggs laid among hairs of cat or dog.

Cat and Dog Flea. (Pulex serraticeps)

Control.—Keep the cats and dogs free by dusting into the hairs insect powder; provide special sleeping mats and destroy these occasionally; scatter naphthaline over the floor and keep room tightly closed for 24 hours.

(f).—Reddish-brown, flat bugs with buggy odour, hiding in day time in cracks, but active at night; with piercing and sucking mouth-parts.

Bed-Bug. (Cimex lectularius)

Control.—Burn sulphur in rooms (2 lbs. to 1000 cub. ft.); cleanse walls and floors thoroughly; inject gasoline into all cracks.

Feeding on or Destroying Clothing, Carpets, Upholstery, Etc.

(a).—Tiny dusky moths, laying eggs in furs or woollens, the larvae eating holes in them.

Case-Making Clothes Moth. (Tinea pellionella)
Webbing Clothes Moth. (Tinea biselliella)
Tapestry Clothes Moth. (Trichophaga tapetzella)

Control.—Beat garments outside and expose to sun for a few hours; spray with gasoline; put woollen garments when thoroughly beaten in sealed bags or boxes for summer.

(b).—Small oval red, black and white beetles, whose grubs are hairy, feeding on carpets on underside usually along a crack of the floor.

Buffalo Carpet Beetle. (Anthrenus scrophulariae)

Control.—Use rugs if possible; beat carpets, spray with gasoline and wash all cracks with hot soap suds, then with gasoline.

(c).—Tiny, active, wingless insects with silvery appearance, and with three long feelers at hind end of body, feeding on linen or paper containing starch, sugar, etc.

Silver-Fish. (Lepisma saccharina)

Control.—Use insect powder where they occur; trap with bits of cardboard dipped in a mixture of paris green and paste.

Feeding on Food Products.

(a).—Active, wary, light-brown insects with a "roachy" odour, found in pantries and bakeries; several species but the most common is the

Croton-Bug or *German Cockroach.* (Ectobia Germanica)

Control.—Use bits of chocolate and borax; or put plaster paris and paris green in one saucer and water in another close to it.

(b).—Brown beetles, $\frac{1}{8}$ inch long, whose grubs are brown above, white below and covered with long brown hairs; found where meats, skins and feathers are kept.

Larder Beetle. (Dermestes lardarius)

Control.—Remove meats, etc., and scrub the shelves, walls and floors thoroughly with soap suds.

(c).—Large black fles with bluish abdomen and with black spines on thorax; eggs laid on meat.

Blow or Meat Fly. (Calliphora vomitoria)

Control.—Use screens on doors and windows.

(d).—Little red ants that have their nests in the wall or beneath the flooring.

House Ants. (Monomorium pharaonis)

Control.—Locate nests and destroy them with carbon bisulphide or boiling water; set out sponges half filled with sugared water in their paths.

(e).—Black ants and Pavement ants living out doors sometimes invade houses.

Black Ant. (Monomorium minutum)

See Sixth Report for a Table of insects feeding on stored vegetable products, such as meal worms and flour moths.

USEFUL KEYS TO SOME ECONOMIC FAMILIES OF INSECTS

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SPHINGIDAE.—(Hawk Moths)

(after Fernald and Smith)

Common Genera.

A.—Tongue long and horny.
- B.—Abdomen with a tuft at tip; diurnal.
  - C.—Middle of wings clear.—*Hemaris.*
  - CC.—Middle of wings opaque.
    - D.—Fore tibia spinose; abdomen not laterally tufted—*Amphion.*
    - DD.—Fore tibia not spinose; abdomen laterally tufted—*Thyreus.*
- BB.—Abdomen not tufted; nocturnal
  - C.—Thorax tufted; outer margin of wings obliquely rounded.
    - D.—Eyes strongly ciliated; fore tibia spinose—*Sphinx.*
    - DD.—Eyes not ciliated and large; head prominent, palpi large—*Phlegethontius.*
    - DDD.—Eyes small; palpi small; outer margin excavated —*Ceratomia.*
  - CC.—Thorax untufted; outer margin of wings more or less excavated.
    - D.—Outer margin of fore wings angulated—*Deidamia.*
    - DD.—Outer margin entire or sinuous.
      - E.—Antennae gradually thickened at tip—*Deilephila.*
      - EE.—Antennae fusiform and recurved at tip— Spurs of middle and hind tibiae long; legs stout —*Philampelus.*
      - EEE.—Antennae short, not recurved at tip; wings more sinuate; head more retracted—*Ampelophaga.*

AA.—Tongue short and membranous.
- B.—Outer margin of fore wings entire and evenly rounded—*Ellema.*
  - C.—Fore tibiae with a stout spine at tip—*Triptogon.*
  - CC.—All the tibiae spinose—*Cressonia.*
  - CCC.—Tibiae not spinose; hind wings with an eye spot.
    - D.—Outer margin of fore wings scalloped—*Paonias.*
    - DD.—Outer margin more or less angulated—*Smerinthus.*

TABANIDAE.—(Horse Flies.)

Common Genera.

A.—Hind tibiae with spurs at tip; third segment of the antennae with five rings; second segment but little shorter than the first; wings with dark markings—*Chrysops.*

AA.—Hind tibiae without spurs; third segment of the antennae with a well-developed process—*Tabanus.*

TRYPETIDAE.—(Fruit Flies.)

Common Genera.

A.—Bristle on each side of front with a terminal leaf-like appendage—*Ceratitis.*

AA.—Front without such bristles.

B.—Wings with coloured markings not reticulate; Scutellum not with six bristles; 4th long vein not conspicuously curved forward at its extremity; Covering of body never black.

C.—Wings with four very oblique black cross bands; cross veins not approximated. Scutellum with four bristles yellow—*Rhagoletis.*

CC.—Cross bands on wings nearly transverse; cross veins but little oblique—*Trypeta.*

CERAMBYCIDAE.—(Long-horn Beetles.)

Common Economic Genera.

A.—Thorax margined; labrum united with clypeus, body broad and depressed.

B.—Antennae 11-jointed; body elongate, parallel—*Orthosoma.*

BB.—Antennae 12-20 jointed; body stout, broad—*Prionus.*

AA.—Thorax not margined; labrum free; body oblong and cylindrical.

B.—Front tibiae obliquely grooved on inner side; last joint of palpi pointed at tip.

C.—Elytra spined; size small—*Psenocerus.*

CC.—Elytra not spinose; large size.

D.—Scape of antennae with an apical scar; body elongate—*Monohammus.*

DD.—Scape of antennae without apical scar.

E.—Tarsal claws divaricate and simple—*Saperda.*

EE.—Tarsal claws divaricate and cleft.

F.—Eyes not divided; thorax cylindrical—*Oberea.*

FF.—Eyes divided; thorax with blunt tubercle on each side and marked with four black spots—*Tetraopes.*

BB.—Front tib ae not grooved; last joint of palpi not pointed at tip.

C.—Base of antennae partly enveloped by the eyes; front coxae not conical; eyes finely granulated; scutellum rounded behind; tibial spurs large.

D.—Head small; process between hind coxae rounded.

E.—Thorax transversely excavated at sides and with three yellow cross bands—*Cyllene.*

EE.—Thorax not excavated at sides and without yellow cross bands—*Plagionotus.*

DD.—Head large; process between hind coxae acute—*Clytus.*

CC.—Base of antennae not enveloped by the eyes; front coxae conical.—*Desmocerus.*

CURCULIONIDAE.—(Weevils.)

Common Economic Genera.

A —Claws simple, pygidium not exposed.

B.—Antennae straight, club annulated, claws toothed, gular peduncle broad—*Ithycerus.*

BB.—Antennae elbowed, rostrum with distinct scrobes, gular peduncle long; front coxae contiguous.

C.—Mandibles usually emarginate, 2-toothed at tip—*Phytonomus.*

CC.—Mandibles bi-emarginate, 3-toothed at tip.

D.—Lateral angles of first ventral segment uncovered—*Lixus.*

DD.—Lateral angles of first ventral segment not visible.—*Pissodes.*

AA.—Claws appendiculate, toothed or cleft (except in Tyloderma).

B.—Ventral sutures straight, hind angles of prothorax rectangular or rounded, prosternum short, broadly emarginate, eyes rounded distant—*Anthonomus.*

BB.—Ventral sutures more or less curved.

C.—Beak received in or upon the breast in a pectoral groove confined to prosternum; beak long; tarsi dilated; front coxae contiguous—*Conotrachelus.*

CC.—Pectoral groove extending into the mesosternum, sharply limited behind; front coxae not contiguous; metathoracic epimera distinct, mesosternum feebly emarginate —*Tyloderma*.

FRUIT-TREE SCOLYTIDS.—(Bark Beetles)

Three Economic Genera.

A.—Venter of abdomen with caudal part bent abruptly upwards. Antennal club flat and marked by angulated sutures—*Eccoptogaster rugulosus*. (Fruit-tree bark beetle).

AA.—Venter of abdomen normal, regularly curved.

B.—Antennal club lamellate, of three separate, laterally-produced segments; head visible from above—*Phloeotribus liminaris*. (Peach-tree Bark-beetle).

BB.—Antennal club globular; truncate at tip, head deeply imbedded in prothorax whose anterior margin is nearly horizontal and invisible from above.—*Xylèborus dispar*. (Shot-hole borer).

ORTHOPTERA.

The Genera and Species of Blattidae.

A.—Last ventral segment of female abdomen plane not compressed; fore femora rarely provided with spines.

B.—Sub-genital stylets present in the males, upper wings of females short—*Ischnoptera*.

I. Pennsylvanica brown, sides of pronotum yellow.

BB.—Sub-genital stylets absent in the males. Upper wings of both sexes long—*Blattella*.

B. Germanica (Croton bug), length ½ inch.

AA.—Last ventral segment of female abdomen compressed and divided; fore femora spined.

B.—Wing covers not reaching tip of abdomen.—*Blatta*.

B. Orientalis (Oriental Cockroach).

BB.—Wing Covers reaching beyond the abdomen—*Periplaneta*.

C.—Wing covers much exceeding abdomen—*P. americana*.

CC.—Wing covers but little exceeding abdomen; a bright yellow stripe on basal half of their outer margin—*P. Australasiae*.

Acrididae.

Sub-families, Genera and Species.

Sub-Families.

A.—Pronotum extending over abdomen; claws of tarsus without pulvillus; size small—*Tettiginae.*

AA.—Pronotum not extending over abdomen; claws of tarsus with pulvillus; Size larger.

B.—Prosternum with tubercle—*Acridinae.*

BB.—Prosternum without tubercle.

C.—Vertex and front of head meeting at an acute angle—*Tryxalinae.*

CC.—Vertex and front rounded—*Oedipodinae.*

Genera of the Tettiginae.

A.—Antennae 12-jointed and pronotum rounded—*Batrachidea.*

AA.—Antennae 13-14-jointed; pronotum horizontal—*Tettix.*

AAA.—Antennae 22-jointed; pronotum horizontal—*Tettigidea.*

(For species see Blatchley's *Orthoptera of Indiana.*)

Genera of the Acridinae.

A.—Wings as long or longer than the abdomen.

B.—Pronotum sloping from median carina; extremity of abdomen in males not swollen—*Acridium* or *Schistocerca.*

BB.—Pronotum flattened; extremity of abdomen in males swollen—*Melanoplus.*

Species of Acridium.

A.—Size large; antennae rather short—*A. americana.*

AA.—Size medium; antennae longer.

B.—Colour yellowish brown or olive green—*A. alutacea.*

BB.—Colour rusty brown; no yellowish stripe on dorsum—*A. rubiginosa.*

Species of Melanoplus.

A.—Apex of last abdominal segment of male distinctly notched.

B.—Length of body to tip of wing covers 29-35 mm—*M. spretus.*

BB.—Length of body to tip of wing covers 23-26 mm.—*M. atlanis.*

AA.—Apex of last abdominal segment of male entire, or at least obscurely notched—*M. bivittatus.*

1.—Anal cerci enlarged at apex.

2.—Anal cerci tapering.

A.—Species of medium size; anal cerci much narrowed, but without a notch.—*M. femur-rubrum.*

(B).—Species of large size; anal cerci suddenly narrowed, making a prominent right-angled notch on lower side—*M. differentialis.*

Genera of the Tryxalinae.

A.—Foveolae of Vertex present, and visible from above. Lateral carinae of pronotum incurved—*Stenobothrus.*

S. curtipennis (Short-winged brown locust).

AA.—Foveolae absent; lateral carinae nearly parallel—*Chrysochraon.*

C. conspersum (Sprinkled locust).

Genera and Species of Oedipodinae.

A.—Wings with the disk yellow.

B.—Apical half of wing dusky.

C —Dorsal aspect of head with a slight median carina which is quite prominent in the central foveola.—*Encoptolophus sordidus* (Clouded locust).

CC.—Dorsal aspect of head without median carina; central foveola less distinct—*Chortophaga viridifasciata* (Green-striped locust).

BB.—With a dark band across the wings—*Spharagemon aequale.*

AA.—Wings with the disk black—*Dissosteira carolina* (Carolina locust)

Genera and Species of Locustidae.

A.—Wingless or with rudimentary wings and wing covers.

B.—Pronotum not extended over meso-and metanotum—*Ceuthophilus.*

BB.—Pronotum extended over meso-and metanotum—*Thyreonotus.*

AA.—Winged.

B.—Tegmina expanded in the middle.

C.—Tegmina much broadened in the middle, concave—*Cyrtophyllus.*

CC.—Tegmina somewhat broadened in the middle, not concave.

D.—Ovipositor very small—*Microcentrum.*

DD.—Ovipositor of medium size—*Amblycorypha.*

BB.—Tegmina not expanded in the middle.

C.—Vertex of the head with a conical projection forwards—*Conocephalus.*

CC.—Vertex of the head without a conical projection.

D.—Ovipositor straight or very nearly so; insect small—*Xiphidium.*

DD.—Ovipositor curved; insect large.

X.—Ovipositor curved sharply upwards—*Scudderia.*

Y.—Ovipositor sword-shaped—*Orchelimum.*

Species of Ceuthophilus.

A.—Fore femora about as long as pronotum—*C. maculatus.*

AA.—Fore femora longer than pronotum—*C. brevipes.*

Species of Thyreonotus.

A.—Pronotum well rounded behind—*T. dorsalis.*

AA.—Pronotum nearly square—*T. pachymerus.*

Genera and Species of Gryllidae.

A.—Fore tibiae broad, fitted for digging (Fossorial crickets).

B.—Insect small; antennae ten to twelve jointed—*Tridactylus.*

BB.—Insect large; antennae many-jointed—*Gryllotalpa.*

AA.—Fore tibiae slender.

B.—Hind femora stoutish (True crickets).

C.—Last segment of the maxillary palpi of the same length as the next to the last—*Gryllus.*

CC.—Last segment of the maxillary palpi double the length of the next to the last—*Nemobius.*

BB.—Hind femora slender (Tree crickets)—*Oecanthus.*

Species of Gryllus.

A.—Black field crickets.

B.—Ovipositor 13-14 mm. long; male more slender—*G. pennsylvanicus.*

BB.—Ovipositor 18 mm. long; male stout—*G. abbreviatus.*

AA.—Straw coloured house crickets—*G. domesticus.*

Species of Nemobius.

A.—Ovipositor longer than hind femora and straight; colour blackish arranged in longitudinal bars—*N. fasciatus.*

AA.—Ovipositor shorter than hind femora and arcuate—*N. exiguus.*

Species of Oecanthus.

A.—Antennae with one black mark on each basal joint.

B.—Black marks like small rounded dots—*Oe. niveus.*

BB.—Mark on first joint long and hooked, that on second oblong —*Oe. angustipennis.*

AA.—Antennae with two black marks on the first two basal joints.

B.—Antennae wholly black, also head, thorax and legs. Marks on first joint of antennae generally connected at apex—*Oe. nigricornis.*

BB.—Pale greenish white; marks on antennae elongate, parallel distinct—*Oe.* 4-*punctatus.*

AAA.—Antennae without marks on first joints, wing covers broad: head and first joints of antennae pink.—*Oe. latipennis.*

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